

RAILWAY ENGINEERING

AND MAINTENANCE OF WAY.

BRIDGES · BUILDINGS · CONTRACTING · SIGNALING · TRACK

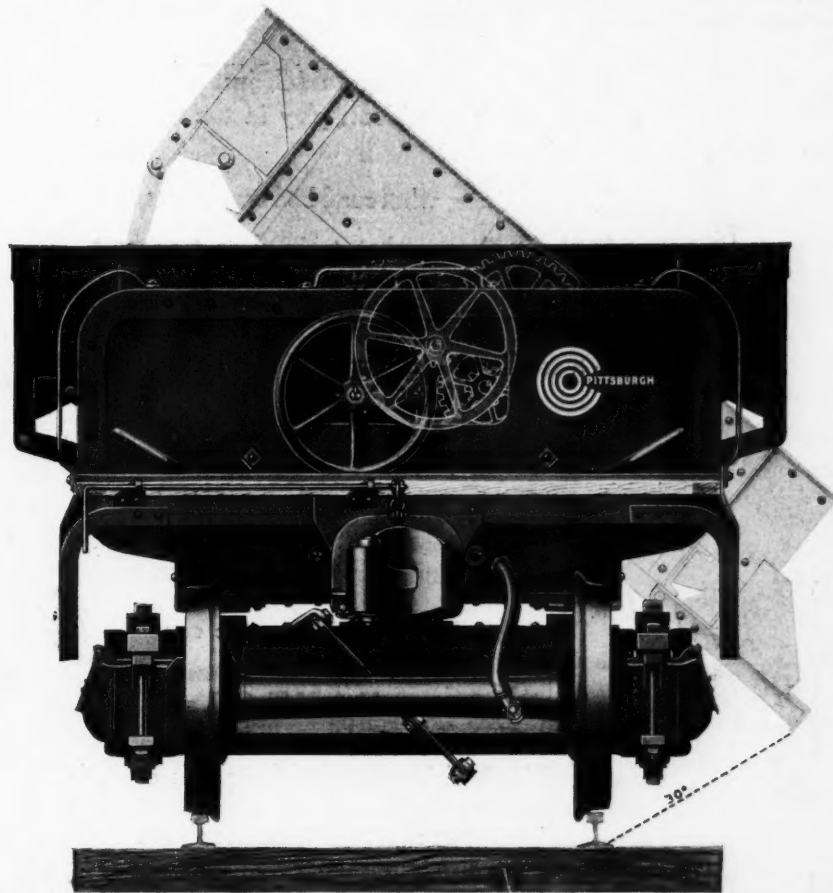
New Series, Vol. IX
Old Series, Vol. XXVIII

Chicago

MAY, 1913

New York

No. 5



CLARK EXTENSION SIDE DUMP CARS

SUPPORT THE DOORS THROUGHOUT THEIR LENGTH, OPEN
THEM TO WHERE THEY PROTECT THE TRUCKS AND TRACK
AND LEAVE CLEAR SPACE ABOVE TO DISCHARGE THE LOAD

4 TO 7 YARDS ON FOUR WHEELS

12 TO 20 YARDS ON EIGHT WHEELS

HAND OR AIR DUMP, OR BOTH

FOR SALE OR LEASE. PROMPT DELIVERY

STEEL CONSTRUCTION

WOOD LINING IF DESIRED

CLARK CAR COMPANY

2121 OLIVER BLDG.

PITTSBURGH, PA.

There's A Stability Here Proved Best By Every Test

Did you ever stop and think just what important part Track Tools play in the railroad life of the world?

Without them, what road-bed would be safe?

Without them, what train dare transport human or other freight?

Without them, what capital dare venture into a road's up-building?

Track Tools

are the indispensable backbone strengtheners of every large and growing R. R. business—the conception of dividends.

But there are TrAcK ToOlS, and TRACK TOOLS!

The so-called TrAcK ToOl, built for profit only, is the open switch of improvident purchase. Hard usage ever dulls its efficiency at most inopportune times.

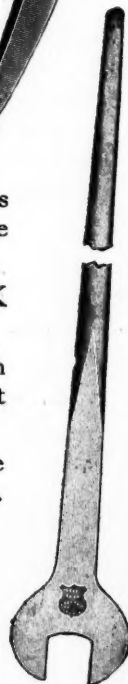
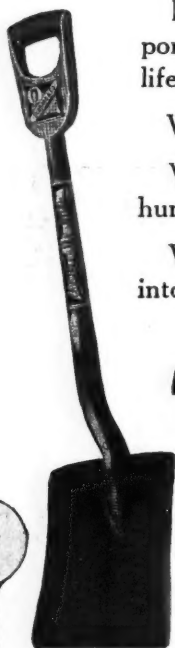
For 20 years we have manufactured real TRACK TOOLS.

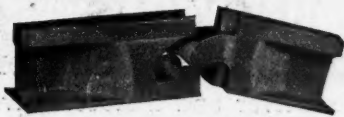
We build them of selected materials, and with such precision and care that they always render the most exacting service.

Suppose you look over the HUBBARD LINE at the American Railway Engineering Association convention.

Our exhibit will furnish you food for thought.

HUBBARD & CO
PITTSBURGH





Interlocking Rail Joint in Position
for Application

--NOISELESS--



Interlocking Rail Joint Locked

INTERLOCKING RAIL JOINTS

Save in *Initial* cost of Laying Rails *because* there are

No Angle Bars, Bolts or Bond Wires Required

Save in *Ultimate* Cost in Greater Proportion *because* of

Longer Life of Rail—No Bolt or Angle Bar Replacements Necessary

**They Eliminate Low Joints and Vibration, and Allow
Equal Expansion and Contraction at All Joints**

Write for further information.

BRANCH OFFICES:

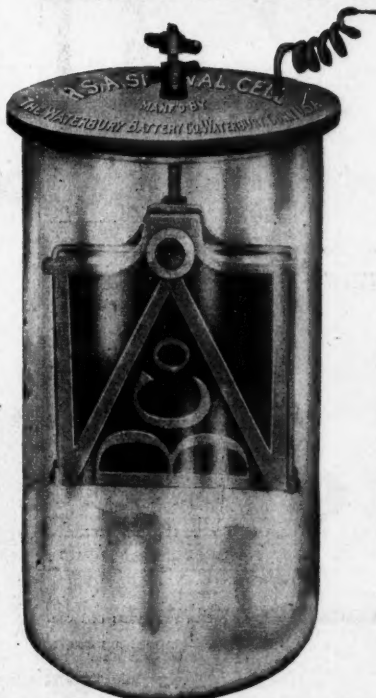
NEWARK
CLEVELAND
ST. LOUIS
DALLAS
SALT LAKE CITY

International Interlocking Rail Joint M'f'g. Co.

General Offices: 1102-3 Karpen Bldg., Chicago

Home Office: 617 Colorado Bldg., Denver

The Last Word in Primary Battery Construction Schoenmehl's Improved Copper Oxide Plate



The improvement consists in winding the copper oxide plate with wire. This wire winding solves the three most difficult problems in battery construction:

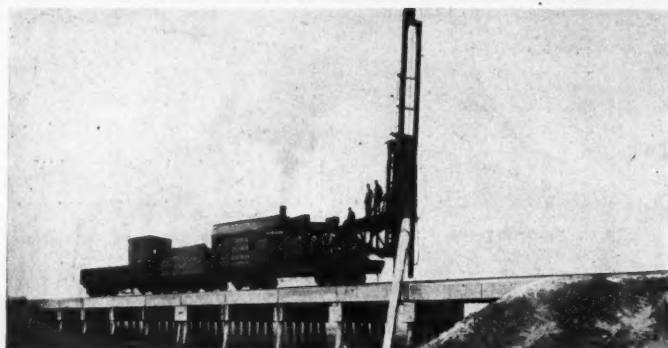
- (1) It increases the conductivity of the battery, brings the various parts of each surface into contact with the wire, and thus into conductive relation with each other and makes both surfaces a unit of conductivity.
- (2) It prevents short circuiting as a result of flaking or scaling by holding the scales fast to the plate and keeping their size down so that even if they should drop they cannot reach the zinc element.
- (3) It overcomes the objection of lack of economy which characterizes the thick plate and makes possible a thin plate which is fully as strong and much more economical than the thick one. Heretofore plates had to be made thick on account of the liability to breakage from handling under commercial conditions if they were made thinner. Schoenmehl's new plate can remain in service until all of the oxide has been exhausted, thus giving the maximum of economy.

This improvement in copper oxide plate construction is the invention of C. B. Schoenmehl, the pioneer of the battery business. From now on it will be an exclusive feature of Schoenmehl's R. S. A. Signal Cells.

Waterbury Battery Company
WATERBURY, CONN.

RAILWAY ENGINEERING

AND MAINTENANCE OF WAY



Bucyrus Locomotive Pile Driver Driving Concrete Piles on The C. B. & Q. Ry.

BUCYRUS Locomotive Pile Driver

A Pile Driver and a Locomotive
in One

WITH SUFFICIENT ENGINE POWER
TO PROPEL 250 TO 300 TONS AT 25
TO 30 MILES PER HOUR, OR 200
TONS UP A 1% PER CENT GRADE
AT 10 MILES PER HOUR.

We also build Shovels of all sizes, Dragline Excavators,
Dredges, Wrecking Cranes, Locomotive Pile
Drivers and Unloading Flows



BUCYRUS COMPANY



South Milwaukee, Wis.

New York
U-6-1

Chicago

Birmingham

Duluth



FOLD IT UP AND CARRY IT LIKE A SUITCASE

THAT'S THE WAY YOU DO IT WITH THE "TRANCO" FOLDING VELOCIPEDE

WEIGHT 52 POUNDS

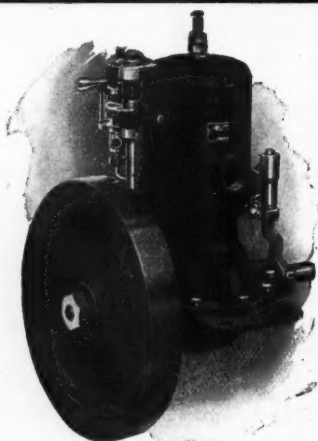
Is folded by simply loosening a thumb-screw.
Easily carried in one hand.
When folded, standing on end occupies floor space 12 by 24 inches.
Ball bearings throughout.
Speed of 20 miles per hour.
Strongest possible construction consistent with light weight.

FOLDED IN 15 SECONDS

Is invaluable as a one-man car.
Will accommodate 2 men when extension seat is attached.
Is ideal car for inspection—linemen, signalmen, etc.
Can easily be placed in a caboose, baggage car, or carried around a train by one man.

CIRCULAR AND PRICE ON REQUEST

TRACK NECESSITIES CO., 36 WEST VAN BUREN STREET CHICAGO



Weight
160 lbs.
4 H. P.

Belle Isle Engines

For Section Cars

Powerful—simple—reliable—two-cycle engines that will drive a car over any grade in the country and have a punch left for a head wind. It's a motor you'll be proud to own—and look at the hard work it will save you every day.

Build Your Own Motor Car

We know exactly what you need and furnish everything complete so that the installation can be made with ordinary tools.

Smaller Sizes for Velocipedes.

CONCRETE FORM & ENGINE CO.

502 Wayne County Bank

Detroit, Mich.

THE MIGHTY FAIRMONT

GASOLINE ENGINES FOR HAND CARS



The FAIRMONT WAY
8 MEN, PUSH-CAR & 45 TIES HANDLED SUCCESSFULLY
WITH 3 H.P. FAIRMONT ENGINE



The FAIRMONT ENGINE
SAME CREW STARTING OUT TO WORK

The Fairmont Way.
Runs either way on track without turning car around.
Starts a big load without pushing the car.
Fully equipped and can be put on car in two hours and run.
Great Power—Light Weight.
We make a special car for Roadmasters' Inspection purposes.
Write today for full particulars and easy payment plan.

FAIRMONT MACHINE CO., Fairmont, Minn.

Trestle Filling, Raising Grades, Widening Road Beds

Can be economically and satisfactorily done
with

Western Air Dump Cars



Prominent railroads have stated that material can be handled at least 50 per cent cheaper with Western Dump Cars than by the old method.

They dump their loads clear, so train can pull out without any shovelling by hand. This is a big saving in time and labor.

Our catalog contains many interesting facts

Write for it today

Western Wheeled Scraper Co.
AURORA, ILLINOIS

EARTH & STONE HANDLING MACHINERY



Insulated Wires and Cables

will continue giving satisfactory service long after their purchase has been forgotten—made in but one grade—the best.



Look for the Ridge

A distinguishing mark on *genuine* OKONITE insulation consists of a single ridge running the entire length of the wire.

The Okonite Company

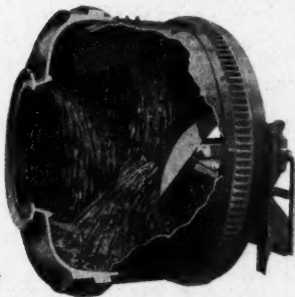
252 Broadway, New York

Central Electric Company,

General Western Agents

320-326 S. 5th Ave., Chicago

K Three Independent Mixing Actions K



Before you recommend a Concrete Mixer, be sure you know all about

THE KOEHRING

The three independent mixing actions in the KOEHRING cause a continual intermingling of all material in the drum. This enables you to do three times as much mixing as you could with a machine enjoying only one mixing action.

Our EXTENSION LOADER feature was especially designed for railroad work.

If your superior officer asked you about the KOEHRING, would you acknowledge that you were unacquainted with its superiorities?

You can get a KOEHRING CATALOG for the asking.

KOEHRING MACHINE CO
MILWAUKEE, WISCONSIN


(COUPON)

KOEHRING MACHINE CO., Milwaukee.

Send me your full Catalog on the Koehring Mixer. I want to secure knowledge which will, perhaps, be beneficial to my success.

.....
.....
.....

RAILWAY ENGINEERING AND MAINTENANCE OF WAY

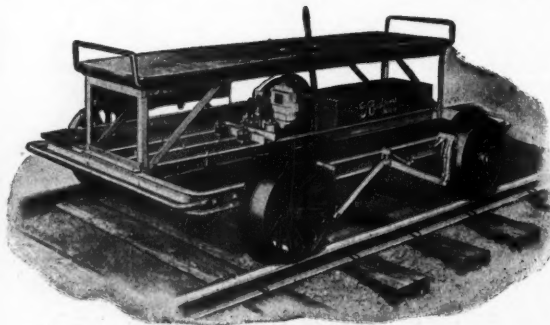


THE SUN NEVER SETS ON VERONA TOOLS
TRACK TOOLS - TRACK JACKS - LEVELS
GAUGES - NUT LOCKS
VERONA TOOLWORKS.
PITTSBURGH,
CHICAGO.

WE HAD IT ALL FIGURED OUT

We Knew

That if we took the well-known "Rockford" Engine, and mounted it in a welded steel channel frame and eliminated dry cells, spark coil and timer, substituting therefor Magneto Ignition, and eliminated chain drive to cam shaft, substituting therefor direct drive through spiral gears, enclosed and running in oil



No. 4 Rockford Magneto Car

WE WOULD HAVE A WINNER IN THE

"Rockford"

**RAILWAY
MOTOR CAR**

SEND FOR CATALOGUE NO. 40
 AND CIRCULARS NOS. 103 - 104 - 105 - 116

Chicago Pneumatic Tool Company

CHICAGO
 1010 Fisher Bldg.

BRANCHES EVERYWHERE

NEW YORK
 50 Church St.



R A M A P O

**Automatic Safety Switch Stands Are Manufactured Only
by the RAMAPO IRON WORKS**

Write for descriptive catalogues on **Switch Stands, Switches, Frogs,
Guard Rail Clamps, Etc.**

Manganese Track Work a Specialty

RAMAPO IRON WORKS

Main Office: Hillburn, N. Y.
Works: Hillburn, N. Y., and Niagara Falls, N. Y.

The Husky Jerry Boy

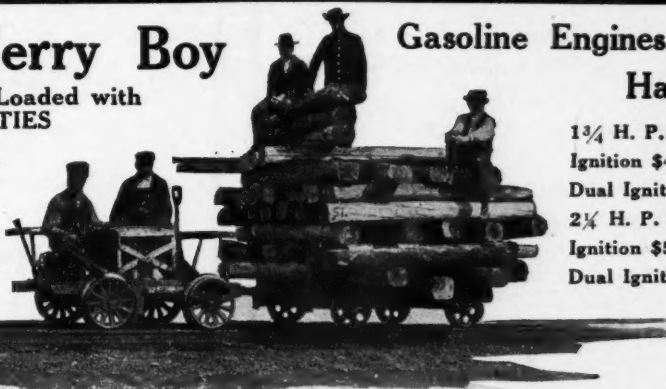
Hauling Push Car Loaded with
73 CROSS TIES

Owner says — could have
hauled 125 easily

Safe—Reliable—Economical

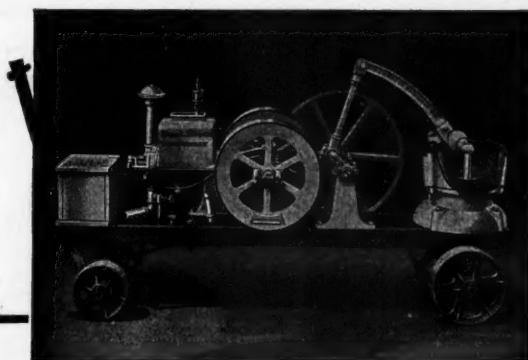
**Associated Manufacturers
Company**

Waterloo,
Iowa



**Gasoline Engines for
Hand Cars**

1 3/4 H. P. Battery
Ignition \$46.00
Dual Ignition \$50.00
2 1/4 H. P. Battery
Ignition \$56.00
Dual Ignition \$60.00



PUMPS 40 GALLONS WHILE PAT STOPS TO LIGHT HIS PIPE

*Put this portable power driven diaphragm
bilge trench pump on your job.*

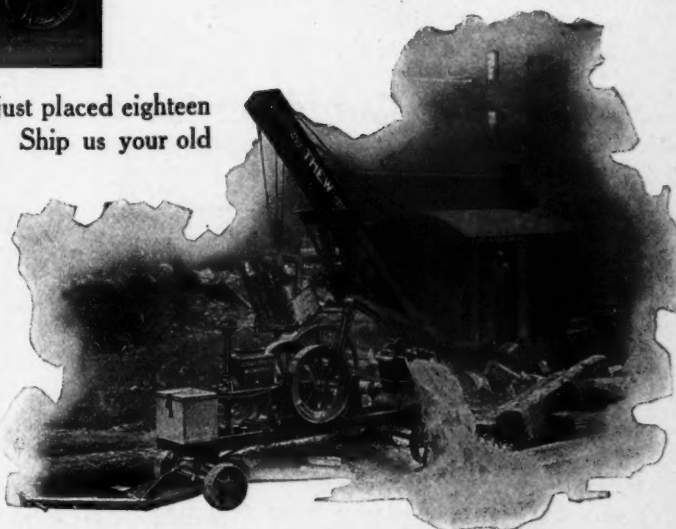
The C. M. & St. P. Ry. Co. have just placed eighteen
of these Pumps on their different jobs. Ship us your old
hand pumps. We will mount them for
you in connection with our Power
Driven outfit.

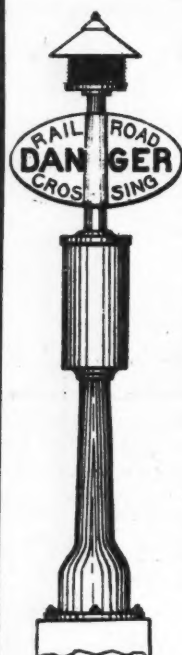
WRITE US

For our attractive catalog—just off the
press.

C. H. & E. Manufacturing Co.
INC.

385 Mineral St. Milwaukee, Wis.





TYPE 50-0S

Our Batteryless

(LOCOMOTIVE TYPE)

CROSSING BELL

Is being made Standard on many Steam and Electric roads because it requires

NO BATTERY
NO RELAYS
NO RAIL BONDING
NO TRACK CIRCUITS
NO CONNECTION WITH TROLLEY OR HIGH TENSION CIRCUITS
NO CONNECTION WITH EXISTING SIGNALS
NO OPERATING EXPENSE
LOW MAINTENANCE

Estimates Furnished

WRITE US

Hoeschen Manufacturing Company
Omaha Nebraska

Andrews Settees



No. 510

Our 1913 Catalog

Shows 40 different designs of settee construction and gives the dimension of each.

Special Work

Designs and Estimates

Promptly Prepared: Without Charge

The A. H. ANDREWS CO.

CHICAGO

Established 1865

Our Products Are Standard

ATLAS RAIL JOINTS, TIE PLATES AND BRACES

ATLAS SWITCH STANDS AND CAR MOVERS



Atlas Tie Plate

Atlas Primer
and Surfacers
for Your Cars



Atlas Standard Suspended Joint

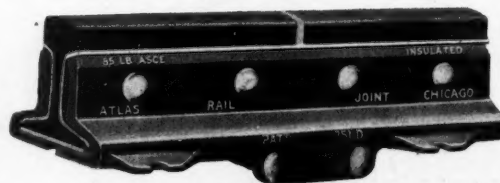
Atlas Compromise and Insulated Joints

Made either of Atlas Special Malleable Iron or of High Grade **CAST STEEL**



Atlas Compromise or Step Joint
Made to Fit any Combination of Rails, Tee or Girder

Made
Either
Suspended
or
Supported



Atlas Insulated Joint

ATLAS RAILWAY SUPPLY COMPANY,

1523-7 Manhattan Building
Phone Harrison 2900 Automatic 69205

CHICAGO

Write for Circular "M"

CALUMET SUPPLY MFG. CO.
CALUMET STEEL CATTLE GUARDS
 STEEL FENCE POSTS
 WING FENCE APRONS
 WE SPECIALIZE IN MAINTENANCE OF WAY EQUIPMENT
 OFFICE 1213 KARPEN BLDG. CHICAGO WORKS HARVEY, ILL.
 WRITE FOR PRICES AND CATALOGUE

IRONITE
 For Waterproofing Concrete, Wood, Brick
 And All Porous Material
 JUST MIX WITH WATER AND APPLY WITH BRUSH
 A Five Year Guarantee Against Saturation
 Approved by U. S. Government
 Sample free on request
 M. J. EGLESTON, Railway Sales Agent
 KARPEN BLDG., CHICAGO

Wyoming Shovels
 Are Built at Our Plant
 and Not Just Assembled
 Every part of a Wyoming
 Shovel is made right here
 at Wyoming—handles of
 the finest second growth
 Northern Ash, and blades
 the highest grade crucible
 and open hearth steel.
 Our trade mark on a
 shovel is a guarantee for
 wear and service.




**THE
Wyoming Shovel Works**
WYOMING, PA.
Established 1873

New York	Chicago
39-41 Cortlandt St.	927 Rookery Bldg.
Boston	Philadelphia
118 Pearl St.	408 Real Estate Trust Bldg.
San Francisco	Nashville
711 Mission St.	608 Church St.

\$25
Cash with Order
 buys this



Mudge Engine Equipment
for Hand Cars

Use this equipment on your hand car and "Lighten your Labor" while you pay the balance at the rate of \$15 per month. Shipment can be made within 24 hours after order is approved.

The Mudge Hand Car Equipment is so simple that anyone can install it in two or three hours. No experience or special tools necessary.

This is the same 2 cyle air-cooled 4 Horse Power engine that has been in service seven years and is running successfully on hundreds of Mudge-Adams Inspection Motor Cars. Its power and durability have been proven.

The aim of the designer in getting up this engine was to make it as simple as it could possibly be and run well. The cutting off of each unnecessary part reduced by that much, the trouble and repairs for the man using the engine. Our engine has only three moving parts.

(The prices in the coupon below are for belt drive. If chain drive is desired add \$5 to purchase price under the plan you wish to accept.)

Mudge & Company,
403 Railway Exchange, Chicago.

I want to buy one of your Mudge Engine Equipment outfits for my hand car and will pay for it

(Check the plan you wish and draw a line through the others.)

\$25; \$25 with this order and \$15 per month.
 \$30; \$40 with this order and \$20 per month.
 \$35; Sight draft attached to bill of lading.
 \$35; Cash herewith.

Please send the outfit to me with shipping ticket made out as follows:

Signed.....
 Occupation..... R. R.....
 Town..... State.....

SALES SERVICE COMPANY-ADVERTISING-CHICAGO

Reinforced Concrete Tanks

ARE NO LONGER AN INNOVATION IN RAILWAY SERVICE.

We Guarantee Our Tanks
UNDER

TRUST COMPANY BOND

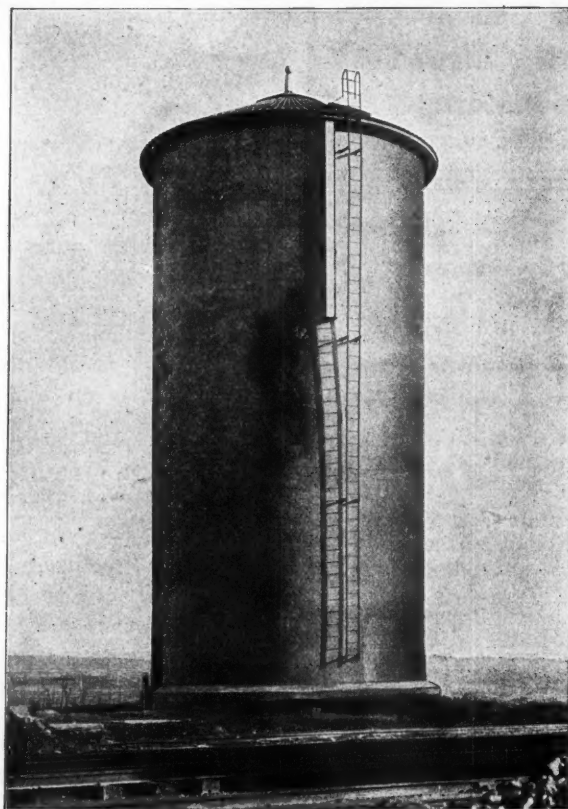
TO BE

Absolutely Water Tight

OUR TANKS MAKE GOOD BECAUSE THEY ARE

↓

Properly
Designed
—
Carefully
Constructed
with
Best
Materials,
Forms
and
Workmanship
Obtainable



↓

Permanent
—
Satisfactory
in
Service
—
Devoid of
Maintenance
Costs
—
Attractive
in
Appearance
—
Economical

TANK BUILT FOR PENN. R. R. CO., IN 1909

THE McCOY PATENT FORMS & METHODS OF ERECTION ELIMINATE IMPERFECTIONS.

WRITE FOR BOOKLET OF CONCRETE
FACTS CONCERNING CONCRETE TANKS.

Steel Concrete Construction Company

1302-3 BERGER BLDG.

:

:

:

PITTSBURGH, PA.

RAILWAY ENGINEERING

AND MAINTENANCE OF WAY.

WITH WHICH IS INCORPORATED

ROADMASTER AND FOREMAN

BRIDGES--BUILDINGS--CONTRACTING--SIGNALING--TRACK

Published by THE RAILWAY LIST COMPANY

WILLIAM E. MAGRAW, Pres. and Treas.
 CHAS. S. MYERS, Vice-Pres. LYNON F. WILSON, Editorial Director
 C. C. ZIMMERMAN, Bus. Mgr. KENNETH L. VAN AUKEN, B. S. C. E., Editor
 J. M. CROWE, Mgr. Central Dist. OWEN W. MIDDLETON, B. S. M. E., Editor
 DALTON RISLEY, Western Manager
 Contributing Editors: B. W. MEISEL, Signaling A. M. WOLF, Concrete

Office of Publication: Manhattan Building, Chicago
 Telephone, Harrison 4948

Eastern Office: 50 Church Street, New York
 Telephone, Courtlandt 5765

Central Office: House Bldg., Pittsburgh
 Address all Editorial and Business Communications to the
 Company at Chicago

A Monthly Railway Journal

Devoted to the interests of railway engineering, maintenance of way, signaling, bridges and buildings. Communications on any topic suitable to our columns are solicited. Subscription price, \$1.00 a year; to foreign countries, \$1.50, free of postage. Single copies, 15 cents. Advertising rates given on application to the office, by mail or in person. In remitting, make all checks payable to the Railway List Company. Papers should reach subscribers by the twentieth of the month at the latest. Kindly notify us at once of any delay or failure to receive any issue and another copy will be very gladly sent. This Publication has the largest paid circulation of any railway journal in the Maintenance of Way field.

Entered as Second-Class matter April 13, 1905, at the Post Office at Chicago, Illinois, Under the Act of Congress of March 3, 1879.

New Series, Vol. 9
 Old Series Vol. 28

Chicago, May, 1913

No. 5

CONTENTS.

Editorial—

Railroad Valuation.....	245
Air Hole Defects in Steel Rails.....	245
Automatic Stops.....	245
Flood Elimination.....	246
Shipping Cement in Bulk.....	265
Joints in Concrete Work.....	265
Today's Man.....	246
Design of Retaining Walls.....	247
Railroad Valuation.....	254
Western Railway Club's Annual Meeting.....	255
Union Pacific Treating Plant at Topeka.....	256
Air Hole Defects in Steel Rails.....	257
Bridges Over Navigable Rivers.....	257
Personals.....	260, 274, 282
Concrete Department—	
Shipping Cement in Bulk.....	265
Joints in Concrete Work.....	265
Truth in Advertising, No. 3.....	266
Expansion and Contraction of Concrete.....	266
Adaptability of Concrete, and Reinforced Concrete precautions.....	270
The Engineer's Distress.....	271
The Signal Department—	
Automatic Block Signals, C., M. & St. P. Ry. Puget Sound Lines.....	272
Personals.....	274
The Maintenance of Way Department—	
Protecting Against, and Repairing Washouts.....	275
Service Tests of Ties.....	277
Rail Ravellings.....	278
Protecting Embankments by Planting Willows.....	279
Testing Track Covered with Water.....	279
Emergency Track Material.....	279
Labor Conditions in the East.....	280
Piece Work for Extra Jobs.....	281
Substituting Piece Work for Day Labor.....	281
Personals.....	282
With the Manufacturers—	
Freight House Door Hangers and Equipment.....	283
Distilled Water for Stations, Shops, and Laboratories.....	284
New Literature.....	284
A Mechanical Automatic Stop.....	284
Industrial Notes.....	285
Patents.....	286

Railroad Valuation.

THE article on another page of this issue, "Railroad Valuation," has called forth considerable criticism from engineers interested in the subject. A great many differences of opinion are apparent in this subject, which is rapidly taking a prominent place in railway activities.

The author discusses the addition of the value of "improvements" to the valuation and later in the paper states that adaptability and solidification of roadbed are legal questions and do not concern the engineer. On the contrary, it seems that it is vitally an engineering question.

Any engineer or trackman who has had to maintain a newly completed track knows the great value of a solidified roadbed. He also knows the careful and expert attention and the labor and money which is constantly required to bring the roadbed to a condition of solidity.

It appears strange, therefore, that the solidifying of the roadbed is not listed as one of the most important "improvements," instead of being assumed to be a legal question.

Practical considerations should be taken cognizance of in all questions pertaining to the cost of upkeep and improvement of a railway. First-class maintenance will constantly improve a railway, and it would seem that part of this maintenance expense, especially in a new line, should rightly be charged to improvement.

Air Hole Defects In Steel Rails.

ON ANOTHER page of this issue there appears a suggested method for testing steel rails for air-hole defects by applying an electric current and comparing the drop of potential with that computed for a solid rail of pure steel.

If air-hole defects were the only defects to be considered, it might be that such a method could be worked out. But there are so many other kinds of defects which are liable to occur, when poor work is done in the rolling mill, that it seems possible such a method might not be reliable.

We must also assume, in using the suggested method, that the rails are of exactly uniform composition, whereas it is not possible to keep the different ingots, or even different rails of the same ingot, of exactly the same proportions. If there is any slag included in the rail, this would again change the resistance. The method, however, might work out in case all impurities, as well as air-hole bubbles, increased the resistance considerably.

Automatic Stops.

CONSIDERABLE interest has been created by the efforts of the New York, New Haven & Hartford to secure, by test, a practical and efficient automatic train stop. It is understood that as soon as the installations can be made two devices will be given thorough trial. One of the devices is almost entirely electrical in its operation, while the other is mechanical.

Until the tests are concluded it is distinctly unsafe to predict the success or failure of either of the devices. As a matter of fact, however, the winning installation in these tests will not necessarily prove the marked success of a certain type, but it will give considerable impetus toward the ultimate perfection of one of the types mentioned. The type of stop which places no electrical

equipment on the steam locomotive is looked upon with favor by many railway officers of the engineering and signal departments and by practically all officers of the mechanical departments for obvious reasons. Wherever it can be avoided, the use of electrical devices on steam locomotives is to be deprecated. In the case of the stop mechanism, electrical equipment on the locomotives will involve the signal department in locomotive repairs in both round house and shop. If this situation proves unavoidable, the work can, of course, be cooperatively performed without serious difficulty. On the other hand, if the stop adopted is the one which is operated mechanically as far as the locomotive is concerned, the matter is simplified at the start.

On electrified lines the devices are perhaps more nearly on a par at the start, as electrical automatic stop equipment on electric locomotives is less objectionable. The mechanical stop is, however, equally adaptable to this class of power and the same advantages hold to a slightly lesser extent.

A feature in the operation of stops, concerning which there is considerable difference of opinion, is the advisability of allowing for the immediate restarting of the train at the option of the engine crew after a stop has been made. It is probable that a compromise adaptation will be made. It is, however, necessary for the success of a type that it be capable of allowing immediate restarting or of enforced delay of a certain predecided interval before it will be possible for the engine crew to proceed with the train.

Flood Elimination

IT is probable that a national movement to prevent the annual recurrence of floods which have, since the beginning of time, been deemed uncontrollable, will result from the agitation of those who have materially suffered from the recent high water in the valleys of the Ohio, the Mississippi and their tributaries. A general educational committee of the National Drainage Congress, consisting of influential men of the country, will meet in Washington, May 22, to present a plan and petition to the United States, and while there this committee will be received by President Wilson. With this committee meets the section on Malaria, composed of state health officers and doctors, headed by Dr. Oscar Dowling of Louisiana; the Engineering and Allied Interests section, headed by Isham Randolph, of Chicago; the Woman's section, headed by Miss Maude M. Griffith, of Clinton, Mo., secretary of the Missouri Woman Farmers' Club; and the Central Cooperative Committee of Reclamation Associations, headed by Charles H. Cartlidge, bridge engineer of the Chicago, Burlington & Quincy R. R.

The flood losses of the country are scarcely appreciated by the public owing to the fact that they usually are confined to relatively small districts, although in the aggregate amounting to great damage and mortality. The spring of 1913 has, however, developed a situation of such serious and wide spreading aspect as to act as a general awakening. When it is considered that the flood losses from 1905 to 1908 totaled \$527,811,720 without any single great disaster it seems difficult to understand the passiveness of the National Government toward a means for better control of surface waters.

The proper control of the inland waters is an engineering problem of great magnitude, but, nevertheless, one which can and will be solved. It has been suggested that certain of the

talent developed by the construction of the Panama canal can be profitably continued in the public service by proper enactment of Congress in the interests of flood control. As in all similar situations of the past, however, we must look to the engineers of railway training for the actual thought and effort which will result in real action.

TODAY'S MAN.

Berton Braley.

When the sages say, "It can't be done at all,
It will only prove a failure and a mess,"
Comes a fellow with a quiet sort of gall,
Just remarking, "We can put it through I guess!"
There's an old and battered briar in his face,
And his eyes are calmly humorous and clear,
For there seems to be an easy sort of grace
And power in the civil engineer!

He will tunnel through the quick-sand and the muck,
He will bridge whatever gulf you want to span,
He has Vision, he has Energy and Pluck;
If you want a Working Dreamer, he's your Man,
In the jungle, fighting fever and the damp,
In the desert where the torrid sun's aglare,
In the bleak and frozen North he pitches camp,
If you show him where the job is—he'll be there!

He has turned the wildest fiction into truth,
He has made the maddest fancies into steel,
He is Alive, he is Daring, he is Youth
Crushing Doubt and all Disaster under heel!
He's Efficiency—that always finds a way!
He is Faith, which conquers Unbelief and Fear,
If you're seeking for the Spirit of Today.
You will find it in the Civil Engineer.

—Exchange.

The Kettle Valley will soon ask for bids for the construction of a section of its railway between the summit of Hope mountains down the valley of the Coquella river to Hope. A 1,600-ft. tunnel will be driven at a point 20 miles east of Penticton, B. C.

The Lake Shore & Michigan Southern has begun the construction of enlarged yards at Air Line Junction and is also building new round houses and car repairs shops.

The Lancaster & Chester, it is reported, will build an extension and the company will increase its capital from \$50,000 to \$500,000.

The Moshannon Central has been said to be incorporated to build a line in Rush township, Center county, Pa.

Application has been made for a charter in New Brunswick to build from Bristol, N. B., east to a point on the National Transcontinental at Juniper Brook.

The Northern Pacific has made surveys for its proposed extension from East Grand Forks, Minn., to Drayton, N. Dak. The route in general runs directly north out of East Grand Forks to a point due east of Grafton, N. D. From there the line strikes off in a northwesterly direction, joining the present Grand Forks to Winnipeg line, 1½ miles south of Drayton.

The Oklahoma, New Mexico & Pacific will probably award contracts soon for the construction of its proposed line west from Ardmore, Okla., west through Lone Grove, Hewitt, Cornish and Waurika to Byers, Tex., connecting with the short line from Byers to Wichita Falls.

The Petaluma & Santa Rosa is constructing a branch 5½ miles in length, 60 pound rails being used.

The Pine Bluff & Sulphur Springs Interurban, incorporated recently, has made surveys for a projected 8-mile line between the places named, in Arkansas.

Design of Retaining Walls*

By Alfred W. Hoffmann.

Copyright 1913, W. E. Magraw.

1st Group. Plain Gravity Retaining Walls

General. Failure of gravity retaining walls can, in most cases, be ascribed to an excessive bearing of the toe on the soil. Excessive soil pressure causes the wall to move out at the top and ultimately to turn over. On rock foundation, stability alone governs the design, while on a soil with greater compressibility the toe pressure is the governing factor.

It is to be regretted that reliable information regarding the deformation of old gravity retaining walls is somewhat scanty. It is, however, generally known that a large number of gravity retaining walls have given more or less trouble by excessive deformations. The necessity of a thorough investigation into the properties of the subsoil, especially the compressibility and the carrying capacity, cannot be too strongly emphasized.

An important factor which often causes failure or undesirable deformations is lack of drainage or insufficient provision for drainage. Lack of drainage is responsible for hydrostatic pressure acting against the back of a wall which was probably not designed to resist such pressure.

To these two causes practically all failures of gravity retaining walls can probably be charged. It seems strange that sometimes other reasons for failure are advanced, which cannot be seriously considered as primary causes. In the Engineering News of Feb. 29, 1912, the failure of a concrete retaining wall is ascribed to the "dynamic action of falling earth." The backfilling is said to have been done carelessly, i.e. without tamping. The process of settling of the back fill is by the author referred to as the falling of the earth. The dynamic action of this process is held responsible for the failure. This writer cannot accept this theory as a plausible explanation of the causes of failure of this retaining wall. It is difficult to comprehend failure of a massive and otherwise safe and stable concrete wall by the negligible impact due to the slow and gradual motion of the settling backfill. If this theory were correct, most retaining walls would probably fail, for the backfilling is more or less carelessly done in the majority of cases. As a matter of fact, other reasons sufficiently plausible can be found to explain this failure. It is mentioned that the ground on

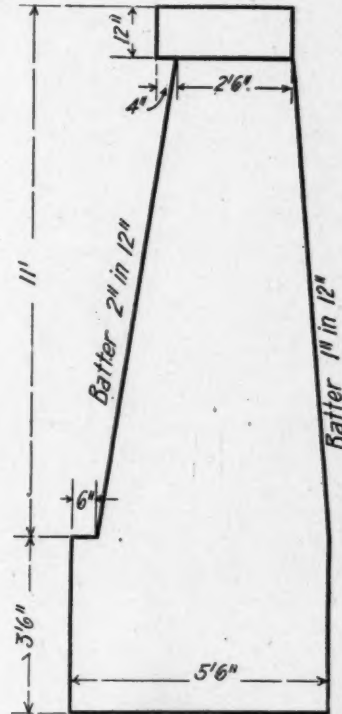


Fig. 9.

which the wall was built was soft, that frequent rains occurred while the backfilling was done, and that a few days after the backfilling was commenced the fill was so soft that it could not sustain the weight of a man walking over it. It is further mentioned that as the fill grew it became less wet but was, until the failure occurred, still very soft and moist. We are probably justified in assuming that this wall was subjected to heavy hydrostatic pressure whereas it was designed to retain a reasonably dry fill. The

* The second of a series of articles on this subject.

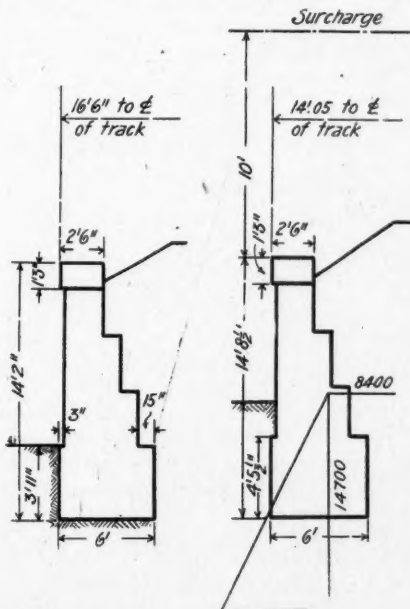


Fig. 10.

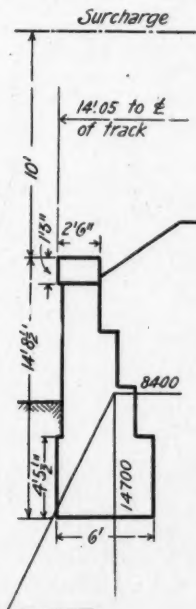


Fig. 11.

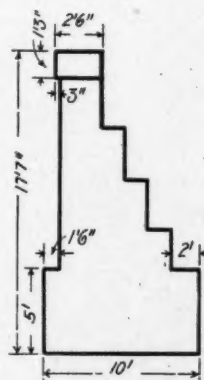


Fig. 12.



Fig. 13.

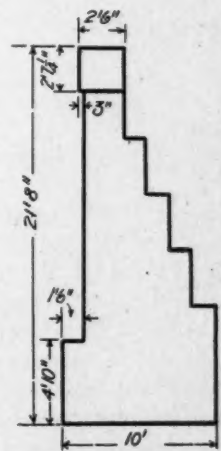


Fig. 14.

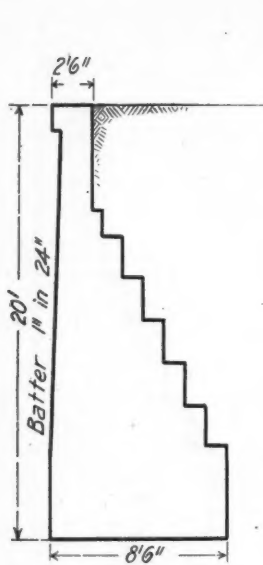


Fig. 15.

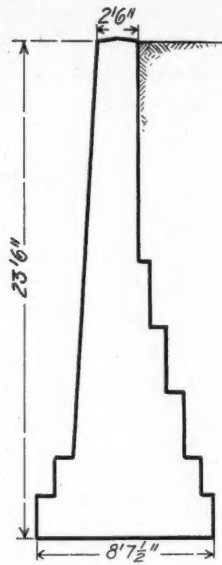


Fig. 16.

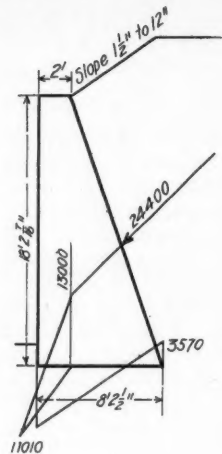


Fig. 17.

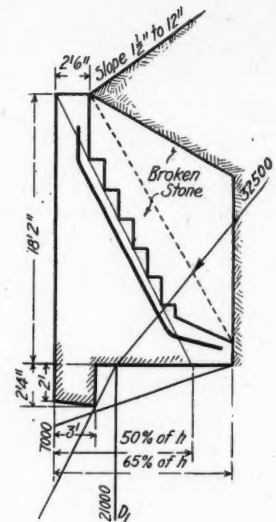


Fig. 18.

author of the article referred to backs his explanation up by the statement that experts found the design of wall to be perfectly stable. The width of the base was 18 ft. 6 in., and the height was 40 ft. 7 1/2 in. The proportion of width of base to height was .455. This wall was to be the abutment for a six-track railroad bridge, and should have been designed to resist a considerable live load thrust. The factor of safety against overturning, if surcharge is not considered at all, is 2.25; and if the surcharge is taken into consideration, it is about 1.4. In this particular case there seems to be little or no doubt that on account of the compressible nature of the soil the structure should have been designed with a much wider base. Even for a base 24 ft. wide or equal to about .6 of the height the toe pressure would have exceeded 4 tons per square foot. If, in addition, we consider the hydrostatic pressure of the moist fill, it seems very simple to explain this failure without resorting to such far-fetched causes as the dynamic action of the falling earth.

It will be shown later that the deformation of a gravity retaining wall due to the internal stress is so small that it can be entirely neglected. Figures representing the deformation of such walls indicate, therefore, practically the amount the top moves out because of the compression of the subsoil under the toe. The Committee on Masonry of the Railway Engineering and Maintenance of Way Association, published in February, 1909, a report on "Retain-

ing Walls and Abutments," to which the writer is indebted for the examples quoted. It must be kept in mind, however, that with hardly an exception, no information was given as to the nature of the soil. With this very important information lacking, it is impossible to arrive at definite conclusions. We must be content to observe general tendencies.

Figs. 9 to 23 show various gravity retaining walls, information regarding which is given in the table, Fig. 24.* Fig. 9 belongs to Type I, all others belong to Type II. The table, Fig. 24, gives the height, width of base, proportion of width of base to height, and the amount the top of the walls is reported to have moved out.

Cracks in a gravity retaining wall are not always signs of impending failure. They are, however, important enough to require a short discussion. Quite frequently the opinion is expressed that it is almost impossible to build gravity retaining walls which will

* These figures are taken from the 1909 Proceedings of the American Railway Engineering Association.

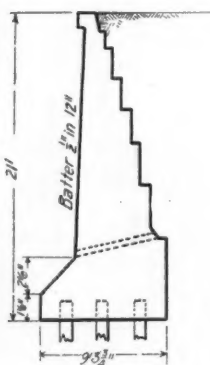


Fig. 19.

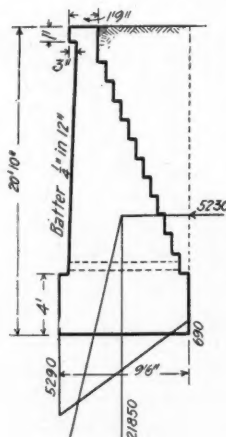


Fig. 20.

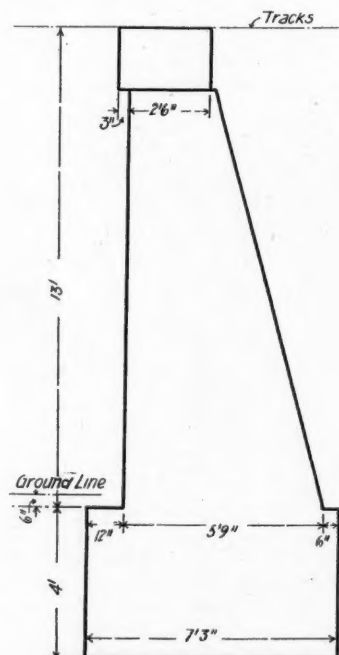


Fig. 21.

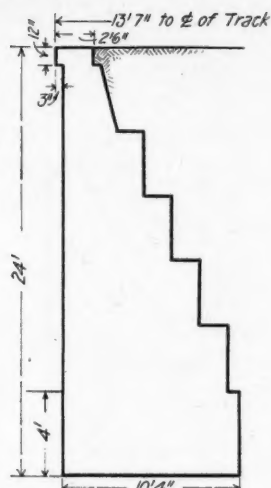


Fig. 22.

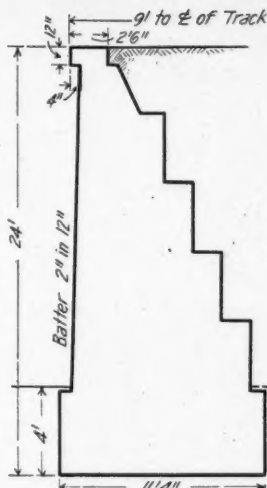


Fig. 23.

remain free from cracks. As a matter of fact, cracks can be avoided by careful design and expert supervision. If it is desired that a wall remain free of cracks, it should be built in short sections separated by construction joints. The length of the sections should not exceed 60 ft. It is also very important to limit the danger of unequal settlement by keeping the bearing on foundation low and as uniform as practicable.

Fig. 25 shows a retaining wall serving as an abutment for a street crossing. It will be seen that in this abutment there have developed large and unsightly cracks along a vertical line down from the parapet of the bridge superstructure. This would indicate that the bearing on foundation under the bridge superstructure was differing materially from the bearing under the wing wall. Open joints between the bridge abutment and the wing wall would probably have eliminated the danger of cracks.

Different from such cracks are those which frequently develop at the corner of retaining walls with wing walls turning off at an angle. These cracks are caused by excessive tensile stresses at the corner, as illustrated in Fig. 26. The top of each wing tends to move out in the direction of the forces acting against the back, and this tendency is resisted by the tensile strength of the concrete only. An analysis of these stresses shows that under ordinary working conditions, and for moderate heights, a rather heavy steel reinforcement is required to supplement the tensile strength of the concrete. It is evident that the tension in the corner section is less for a wall with a wide base because of the reduced danger



Fig. 25.

of the wall moving out at the top. It is sometimes recommended that a joint be placed at the juncture of the two wings. The disadvantage of such a design is that for wings of varying heights the deformations at the top are different if both wings are allowed to move out without being restricted. If keyed together, the keys restricting the movement of the walls are liable to be overstressed and should be proportioned accordingly.

Provision for drainage is made by laying drain pipes of sufficient capacity along the back of the retaining wall, with proper slope, having connection with a sewer or an open ditch in front of the wall.

Waterproofing for retaining walls is not required except for walls under hydrostatic pressure and dams. The best method is to cover the back of the wall with a coat of a waterproofing compound. The method of making the concrete impervious by mixing

Figure	Height h	Base b	$\frac{b}{h}$	Deformation	Remarks
9	14'-6"	5'-6"	.38	?	In all these cases the toe pressure is very great
10	14'-2"	6'-0"	.43	4"	
11	14'-8½"	6'-0"	.4	11"	
12	17'-7"	10'-0"	.57	None	
13	18'-0"	10'-0"	.55	None	
14	21'-8"	10'-0"	.46	2½"	
15	20'-0"	8'-6"	.43	Several inches	Old Walls
16	23'-6"	8'-7½"	.37	15"	
17	18'-2½"	8'-2½"	.45	Failed	Was replaced by Wall shown in Fig. 18 (Rock foundation)
18	18'-2"		.65	None	
19	21'-0"	9'-3½"	.44	None	On piles. The piling takes care of the heavy toe pressure
20	20'-10"	9'-6"	.46	5"	Rubble concrete wall
21	17'-0"	7'-3"	.43	7½"	
22	24'-0"	10'-4"	.43	None	Evidently on a very solid foundation
23	24'-0"	11'-4"	.47	4"	This wall is placed closer to track than Fig. 22.

Fig. 24.

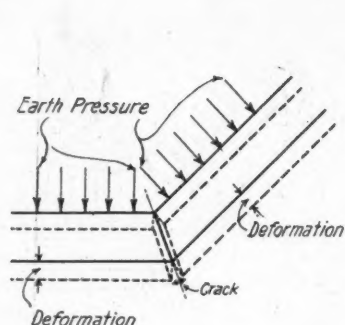


Fig. 26.

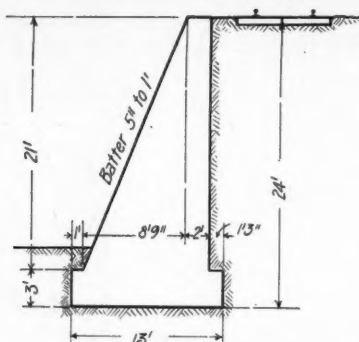


Fig. 31.

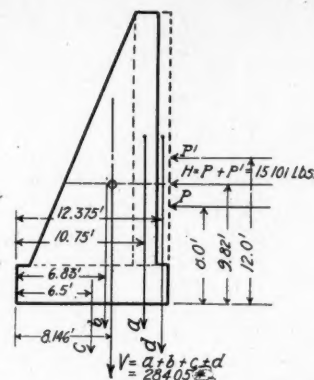


Fig. 32.

with one of the various waterproofing compounds on the market has, to the writer's knowledge, never been used for gravity retaining walls and does not seem practicable considering the massive nature of these structures.

Toe Pressure and Stability. The relation of width of base to height, stability and toe pressure is illustrated by the diagrams, Figs. 27 to 30 for Types I and II. These diagrams were drawn by the writer from numerous computations for both types. The basis for these computations was the same as is shown later in the short discussion of each type.

The diagrams, Figs. 27 and 28, are for Type I. Fig. 27 is for earth pressure only, Fig. 28 for earth pressure and live load thrust resulting from 10 ft. of surcharge. The heavy, full lines indicate the maximum toe pressure in tons per square foot. The heavy dotted lines indicate the factor of safety against overturning, and the light dotted lines show the proportion of width of base to height. All curves below the curve for the factor of safety of 1.5 are shown in light lines, as they are of no value to the designer. A factor of safety of 1.5 is the absolute minimum required for a retaining wall. From Fig. 27 we conclude that the maximum toe pressure allowable for heights up to 36 ft. of walls of Type I, with earth pressure only, is about 4 tons. The curve for the factor of safety against overturning of 1.5 coincides nearly with the curve for a proportion of width of base to height of .375. It is evident, therefore, that such walls are stable if built by the rule that the width of base should be .4 of the height. The governing factor is, then, the allowable toe pressure. From the curves for the toe pressure the width of base required for a certain height can be directly found, and should then be made the basis of a more exact analysis of the wall.

Fig. 28 shows that the maximum toe pressure allowable for heights up to 36 ft. for walls of Type I with earth pressure and 10 ft. surcharge is about 5 tons per square foot. The curve of the factor of safety of 1.5, follows rather closely the curve for a proportion of width of base to height of .5.

Fig. 29 shows the corresponding curves for walls of Type II up to heights of 36 ft., and for earth pressure only. The maximum toe pressure allowable for heights not exceeding 36 ft. is about 8 tons per square foot, and the curve for the factor of safety of 1.5 nearly coincides with the line for a proportion of width of base to height of .34. It is therefore evident that stability is practically no factor at all in the design of retaining walls of Type II. The toe pressure is the governing factor.

The curves for walls of Type II for earth pressure and 10 ft. surcharge are shown in Fig. 30. The maximum toe pressure allowable for heights up to 36 ft. is 10 tons per square foot. The curve for the factor of safety of 1.5 against overturning follows closely the line for width of base to height of .45.

In order to simplify the computations exactly vertical backs or fronts have been assumed, although a slight batter is almost always being used. Such simplifications do not change the results materially. At any rate, the diagrams are exact enough to supply

all information necessary for the preliminary design of a gravity retaining wall for which the local conditions, especially the character of the soil are known.

Type I, Gravity Wall.

This type comprises all gravity retaining walls with vertical or near vertical backs and battered fronts. It is used to advantage wherever a straight front is not specifically required. It is, however, practically excluded from city work where a straight front is more desirable along street lines.

Fig. 31 shows the section through a retaining wall of Type I, of 24 ft. height, retaining an earth fill with a natural slope of $1\frac{1}{2}$ to 1, carrying a live load equivalent to the weight of 10 ft. of earth fill. The width of the base is 10 ft. and the width at the top is 2 ft.

The overturning forces (see Fig. 32), acting on this retaining wall, are the earth pressure

$$P = \frac{24^2}{2} \times 28.6 = 8,237 \text{ lbs.},$$

and the live load thrust is

$$P' = 28.6 \times 10 \times 24 = 6,864 \text{ lbs.}$$

$$H = P + P' = 8,237 + 6,864 = 15,101 \text{ lbs.}$$

These forces produce an overturning moment around the toe of

$$M = 8,237 \times 8 + 6,864 \times 12 = 148,264 \text{ ft. lbs.}$$

Assuming the weight of the concrete to be 150 lbs. per cubic ft., the righting forces and moments are as follows:

	Weight.	Moment.
a. $21 \times 2 \times 150$	$6,300 \text{ lbs.} \times 10.75 \text{ ft.}$	$67,725 \text{ ft. lbs.}$
b. $21 \times \frac{8.75}{2} \times 150$	$13,680 \text{ lbs.} \times 6.83 \text{ ft.}$	$93,480 \text{ ft. lbs.}$
c. $13 \times 3 \times 150$	$5,800 \text{ lbs.} \times 6.5 \text{ ft.}$	$37,700 \text{ ft. lbs.}$
d. $21 \times 1.25 \times 100$	$2,625 \text{ lbs.} \times 12.375 \text{ ft.}$	$32,485 \text{ ft. lbs.}$

$$V = 28,405 \text{ lbs.} \quad M = 231,890 \text{ ft. lbs.}$$

The factor of safety against overturning is

$$\frac{231,890}{148,264} = 1.56.$$

The distance of the resultant H of the horizontal forces above the base is

$$\frac{148,264}{15,101} = 9.82 \text{ ft.}$$

The distance of the resultant V of the vertical forces from the toe is

$$\frac{231,890}{28,405} = 8.146 \text{ ft.}$$

The resultant R of all horizontal and vertical forces passes through the intersection of H and V, and is determined by the dia-

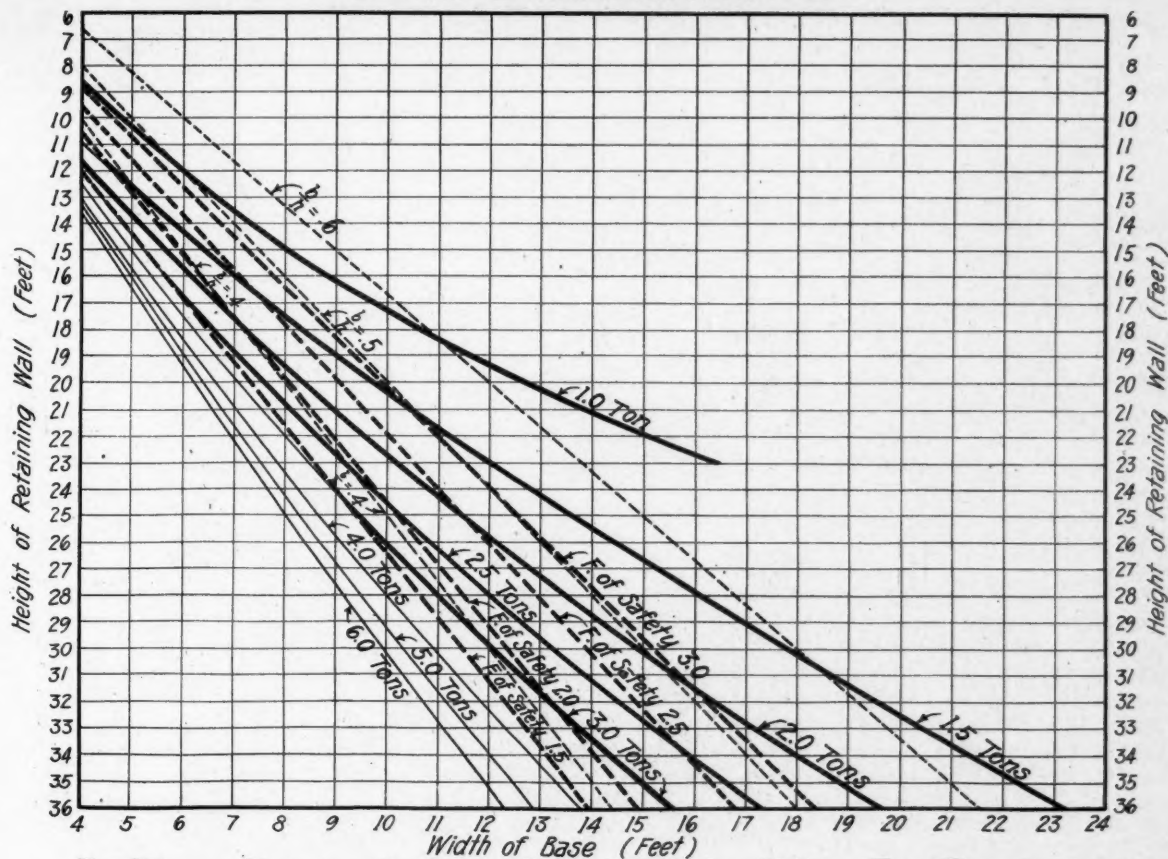


FIG. 27. Diagram for Design of Gravity Retaining Walls. Type I. no Surcharge.

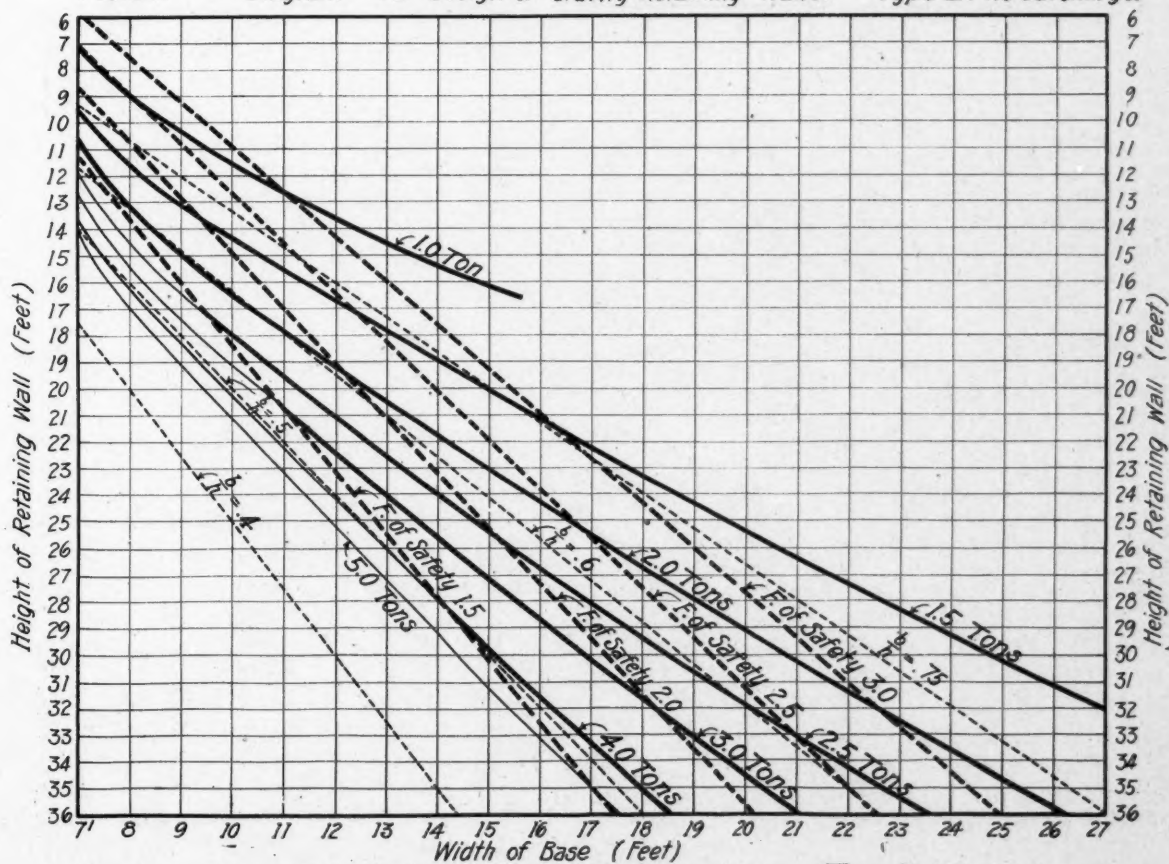


FIG. 28. Diagram for Design of Gravity Retaining Walls. Type I. 10ft. Surcharge.

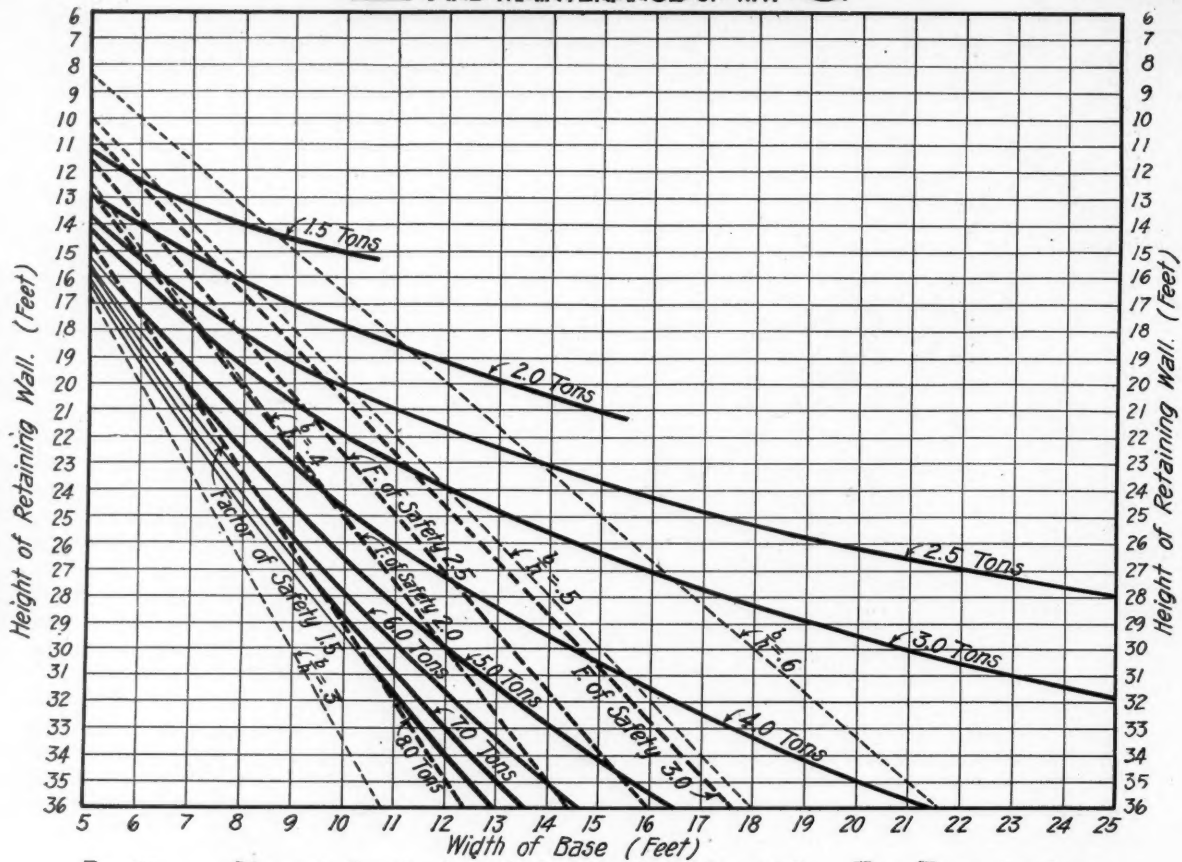


Fig. 29. Diagram for Design of Gravity Retaining Walls. Type II. no Surcharge.

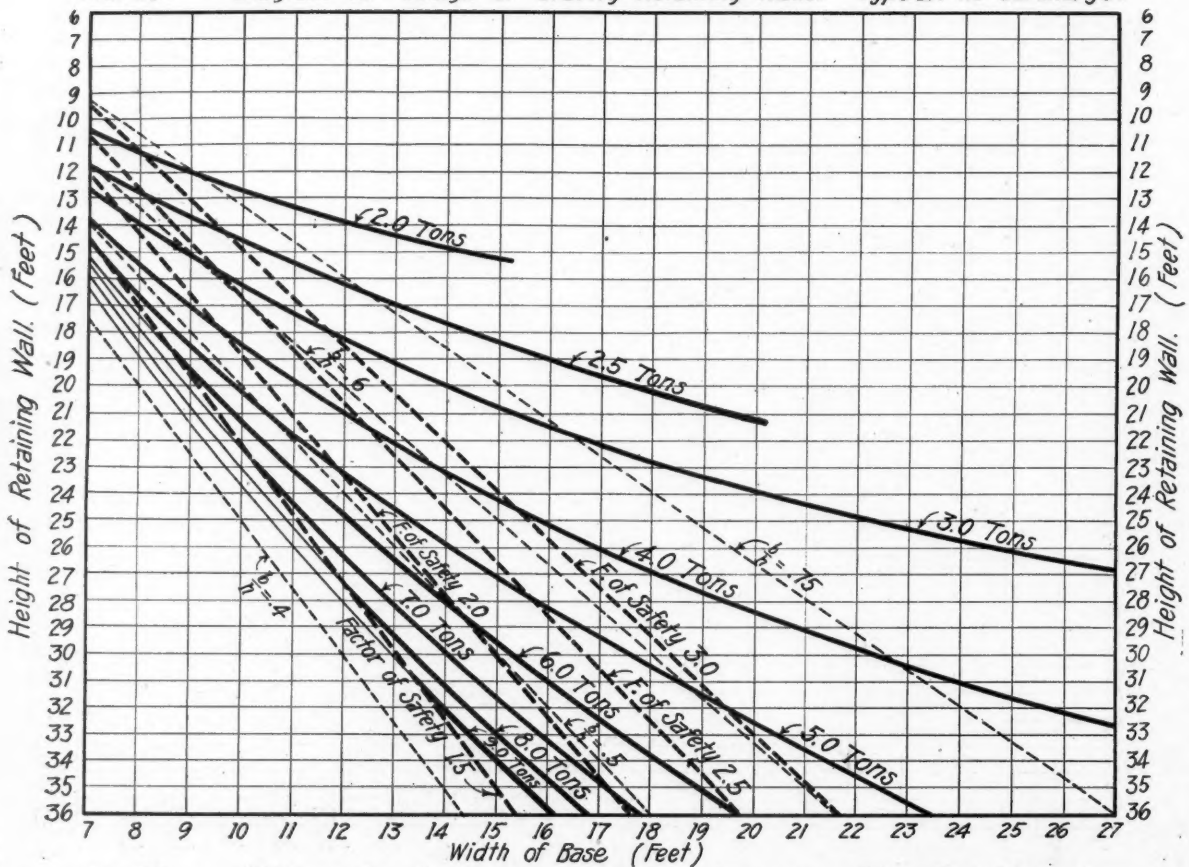


Fig. 30. Diagram for Design of Gravity Retaining Walls. Type II. 10 ft. Surcharge.

gram, Fig. 33. For the intersection of R with the base we have the equation

$$\frac{x}{9.82} = \frac{H}{V}, \text{ whence}$$

$$x = \frac{9.82 \times 15,101}{28,405} = 5.22'$$

The distance from the toe to the intersection of R with the base is, then

$$8.146 - 5.22 = 2.926'$$

The eccentricity $e = 6.5 - 2.926 = 3.574$ ft. e being larger than $\frac{1}{6}$ of the width of base, the resultant passes outside of the middle third. The bearing on foundation extends over

$$3 \times 2.926 = 8.778 \text{ ft.}$$

from the toe. The toe pressure is

$$f = \frac{21,825}{18 \times 2.926 \times 12} = 34.6 \text{ lbs.}$$

per square inch, which is equivalent to 2.485 tons per square foot.

The diagram of the soil pressure is shown in Fig. 34. If piles are used for foundation, then the bearing on piles can be easily found from this diagram if the spacing of piles is assumed, or the

homogeneous material. If the shearing stress or the fibre stress exceed the allowable stresses, then the depth of the footing must be increased, or the section reinforced, or the projection of the toe must be reduced.

On the retaining wall shown in Fig. 31 the shear on the vertical section through the toe of the neatwork is

$$34.6 + \frac{7.778 \times 34.6}{8.778} \times 12 \times 12 = 4,700 \text{ lbs. (See Fig. 34.)}$$

The average unit shear is

$$\frac{4,700}{12 \times 36} = 10.9 \text{ lbs. per square inch.}$$

The bending moment

$$M = 4,700 \times 6.1 = 28,670 \text{ inch lbs.}$$

The compressive and tensile fibre stress

$$f = \frac{28,670}{\frac{1}{6} \times 12 \times 36^2} = 11.1 \text{ lbs. per square inch.}$$

All these stresses are far below the allowable stresses.

The heel of the base does not bear on the soil. It is, however,

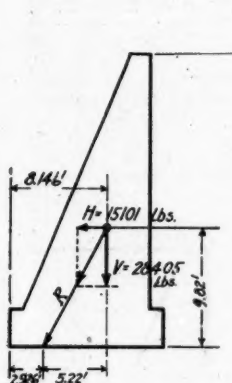


Fig. 33.

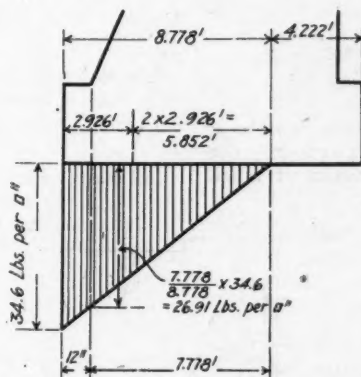


Fig. 34.



Fig. 35.

spacing can be determined to satisfy the desired bearing per pile. It should be kept in mind that in the case of pile foundation the moment of stability should be taken around the top of the pile nearest to the toe instead of around the toe itself.

If the stresses on any horizontal section of the retaining wall are desired, then the resultant of all forces acting above the section under consideration, must be made the basis of the investigation. The stresses can then be found in the same manner as the stresses on the soil. The only difference is that concrete is a material which can take a certain amount of tension. The extreme fibre stresses are the sum or the difference respectively of the unit direct stress and the fibre stress due to flexure. Concrete being much stronger in compression than in tension, the tensile stresses govern. Only a very small percentage of the actual compressive strength of the concrete is made use of. In well proportioned gravity retaining walls the tensile stresses will always be found very low, far below the allowable stress.

The upward pressure of the soil against the base produces bending in the part of the footing projecting beyond the toe of the neatwork. This projecting part is a cantilever, both the maximum shear and the maximum moment occur at the vertical section through the toe of the neatwork. The shear is the total soil pressure outside of this section, and the moment is the product of the shear times the distance between the section and the center of gravity of the shear diagram. The stresses in the section are found in exactly the same way as the stresses in any cantilever of

carrying the fill on the projection of the footing. The heel should, therefore, be strong enough to resist the stresses resulting from this load. The method to be followed is precisely the same as the one described for the toe. The force is, however, acting downward, and the stresses are therefore reversed.

In the wall discussed before, the shear on the heel is

$$1.25 \times 2,100 = 2,625 \text{ lbs.}$$

The unit shear is

$$\frac{2,625}{12 \times 36} = 6.1 \text{ lbs. per square inch.}$$

The moment $M = 2,625 \times 7.5 = 19,700$ inch lbs.

The fibre stress

$$f = \frac{19,700}{\frac{1}{6} \times 12 \times 36^2} = 7.6 \text{ lbs per square inch.}$$

In order to find the maximum deformation of the wall at the top we add together the deformation derived from the elastic line of a cantilever with a uniform load and the deformation derived from the elastic line of a cantilever with a triangular load. The uniform load is represented by the live load thrust, the triangular load by the earth pressure. The deformation due to moments only are considered, the deformations due to direct forces and shears being very small as compared with the deformations due to moments. We assume the moment of inertia of the wall uniform from the bottom to the top. This assumption simplifies the com-

putations and gives results which do not materially differ from the exact figures.

The equation of the elastic line for a cantilever loaded with a uniform load is

$$y' = \frac{W'}{EI} \frac{l^3}{6} \left(\frac{x}{l} - \frac{1}{4} \frac{x^4}{l^3} \right),$$

whence we get a displacement at the top of

$$d' = \frac{W' l^3}{EI 8}$$

The equation of the elastic line for a cantilever with a triangular load is

$$y'' = \frac{W''}{EI} \frac{l^3}{12} \left(\frac{x}{l} - \frac{1}{5} \frac{x^5}{l^4} \right),$$

whence we get a corresponding displacement at the top of

$$d'' = \frac{W'' l^3}{EI 15}$$

The sum of these displacements is

$$d = d' + d'' = \frac{W' l^3}{EI 8} + \frac{W'' l^3}{EI 15} = \frac{l^3}{EI} \left(\frac{W'}{8} + \frac{W''}{15} \right).$$

Applying this formula to the wall, Fig. 31, we get a deformation

$$d = \frac{(21 \times 12)^3}{2,000,000 \times \frac{12 \times 129^3}{12}} \left(\frac{6,864}{8} + \frac{8,237}{15} \right) = .00525 \text{ in.}$$

It can readily be seen that the deformation of a gravity retaining wall due to the work of the internal stresses can be entirely neglected, and that the actually measured deformation of a wall

The shear on section $x-x$ equals

$$H = 15,101 \text{ lbs.}$$

Assuming an allowable unit shear of 30 lbs. per square inch, the extension will have to be made

$$\frac{15,101}{30 \times 12} = 45 \text{ in.,}$$

say 4 ft. wide.

Type I is not so widely used as Type II, on account of the battered front which practically eliminates this type from all city work.

Type II. Gravity Wall.

Type II comprises all retaining walls with vertical or slightly battered front. The analysis of this type is along the same lines as that of Type I. Fig. 36 shows a retaining wall of this type of the same height and width of base as discussed before. The overturning forces and moments are the same. The righting forces and moments (see Fig. 37) are as follows:

	Weight.	Moment.
a. 21 × 2 × 150 =	6,300 lbs. × 2.25 ft. =	14,175 ft. lbs.
b. 21 × $\frac{8.75}{2}$ × 150 =	13,680 lbs. × 6.17 ft. =	84,360 ft. lbs.
c. 13 × 3 × 150 =	5,800 lbs. × 6.5 ft. =	37,700 ft. lbs.
d. 21 × $\frac{8.75}{2}$ × 100 =	9,120 lbs. × 9.08 ft. =	82,840 ft. lbs.
e. 21 × 1 × 100 =	2,100 lbs. × 12.5 ft. =	26,250 ft. lbs.
f. 9.75 × 10 × 100 =	9,750 lbs. × 8.125 ft. =	79,220 ft. lbs.
	V = 46,750 lbs.	M = 324,545 ft. lbs.

The factor of safety against overturning is

$$\frac{324,545}{148,264} = 2.19.$$

All other dimensions and stresses are shown in Fig. 38.

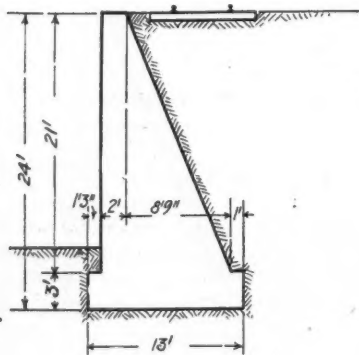


Fig. 36.

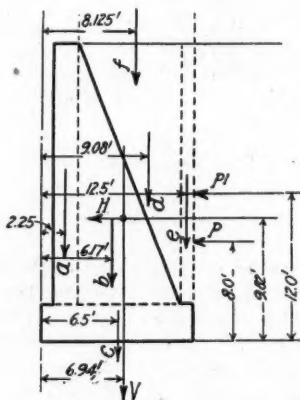


Fig. 37.

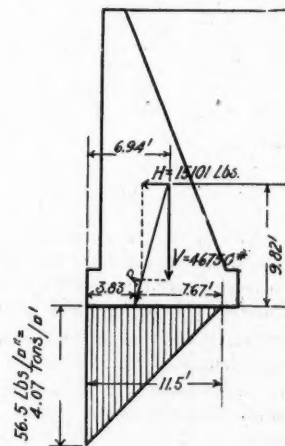


Fig. 38.

represents almost entirely the moving out of the top due to the compression of the soil under the toe.

The only frost protection required for these types of gravity retaining walls is to carry the footings down deeper below the ground than the frost line; 3 to 5 ft. is generally required, according to the climatic conditions.

Sliding. The angle between the base and the resultant of all forces in the retaining wall, Fig. 31, is determined by

$$\tan \alpha = \frac{28,405}{15,101} = 1.881, \text{ whence } \alpha = 62^\circ.$$

If the ground is clayey and wet, there is danger of sliding. This should be prevented by extending the heel down below the base, as shown in Fig. 35.

The majority of all gravity retaining walls are built in accordance with this type. Walls with battered front and back are sometimes found, especially in railroad bridge abutments. The relative economy of types I and II will be discussed in a future installment.

(To be continued.)

RAILROAD VALUATION.*

Reproduction Cost as a Sole Basis for Rates.

By D. F. Jurgenson, member of the Civil Engineers' Society of St. Paul.

The opinions voiced herein are endorsed by the Railroad and Warehouse Commission of Minnesota, the views being arrived at after long and mature deliberation.

The law states that six topics are to be given weight, as is just and right in each case, in determining what the "fair value" of a railway property is. They are as follows:

- (1) Original cost of construction, plus amount expended in improvements, which equals actual cost.
- (2) Amount of bonds and stock.
- (3) Market value of bonds and stock.
- (4) Present cost compared with original cost of construction.
- (5) Probable earning capacity of property under rates prescribed.
- (6) Sum required to meet operating expenses.
- (7) Other matters which appear to warrant consideration in estimating value.

The law, then, appears to be established in that "the carrier is entitled to a reasonable return upon a fair value of the property being used by it for the public convenience." The point in question is, What is meant by "fair value"?

The government aims to secure two conditions in railway rate-making—equality and reasonableness. Equality does not enter into the case except when a division of values between different states arises. We are concerned only with the "reasonable rate" in this case.

Rates may be so high as to be unreasonable, without reference to profit accruing. By reasonable rates we mean rates which cover cost of service, deterioration, depreciation, and a fair return.

The language of the law, "the present as compared with the original cost of construction," indicates that cost of reconstruction should be considered, and it is first necessary to determine what is tangible property and what may properly be included in the inventory.

In the case of *Masters in Shepard vs. Northern Pacific Ry.*, the following were considered and given a value: (1) franchises, (2) good will, (3) going concern, (4) properties to be included, (5) reproduction method.

"Franchises" (1) cannot be included in valuation because it leads to the following absurdity:

A group of individuals obtains the right to organize, exercise the right of eminent domain, and having obtained this authority from the state (the people), it proposes to collect rates or to tax the people for it.

"Good will" (2) is another name for opportunity, and each individual has created a portion of the "good will" as well as the corporation. The same remarks apply to "going concern" (3).

When it is proposed to ascertain present value of "properties to be included" (4), the physical valuation should give only the actual present value of the property then existent, used for transportation purposes.

It is apparent therefore that the "reproduction method" may or may not lead to correct results. It will if the appraiser confines himself to actualities. It will not if the appraiser imagines conditions to exist which do not exist and vice versa.

An instance of the latter was the *Shepard vs. Northern Ry.*, in which the following formula was used: The railway was presumed to be non-existent; that it was necessary for the company to presently acquire each item of property used in the service, and an inventory of the property was made which may, for convenience, be divided into two classes: (a) Land exclusive of improvements. (b) All other properties, including improvements upon land, equipment, bridges, tunnels, etc., under the title "Construction."

The present value of the land was estimated and then multiplied by a coefficient of three, to account for higher prices charged railways for land, damages paid to abutting property, and increase in value of road due to construction and operation of a railway.

The real problem is to find the actual market value; according to the law, "in determining the value of land appropriated for public purposes, the same considerations are to be regarded as in the sale of property between private parties." But later, when the railway is valued, the value is placed at three times the market value, which is unreasonable.

Under "Items of Construction," were considered: (1) Overhead bridges, (2) unit prices, (3) imaginary items, (4) interest during construction.

No allowance was made in the above case for depreciation, which is directly contrary to the rulings of the Supreme Court.

Items of cash on hand, adaptability and solidification of road-bed, etc., do not belong in this discussion, but are legal questions.

An allowance was made for "overhead bridges" (1), which was erroneous, as they had been built by the municipality.

High "unit prices" (2) were assumed, as it was contended that forced construction enhances and makes higher prices, which is an absurdity when considered in the question of valuation.

Interest during construction, contingencies and engineering are "imaginary items" (3), as they depend on the ability of the appraiser to imagine.

"Interest during construction" (4) can be large or small, depending on the rate at which the appraiser imagines the road to be built. As an instance of this, the *Northern Pacific Ry.* in three cases before three different courts was allowed for interest charges during construction, (1) \$23,000,000; (2) \$39,804,651, and (3) \$164,000,000, all cases occurring within the space of one year, with practically the same mileage and equipment.

Engineers, when called upon as experts to furnish information to the judicial tribunals, should base their deductions upon facts and not upon false, dangerously fictitious and imaginary assumptions.

WESTERN RAILWAY CLUB'S ANNUAL MEETING.

The annual meeting of the Western Railway Club will be held at the Auditorium banquet hall May 27th, at which the regular election of officers for the ensuing year will be held. This will be followed by the customary entertainment which promises to be more unique and striking than any preceding it. The fact that the arrangements for this entertainment are being looked after by W. B. Hall, Chairman of the entertainment committee is sufficient assurance of its success. Those taking part in the entertainment are:

J. L. Ponie, J. L. Ponie, Railway Supplies.
 Frank Ryan, Pitts. Spring & Steel Co.
 Albert Young, International Harvester Co.
 J. Roy Andrews, H. W. Johns-Manville Co.
 G. L. Vose, Ill. Trust & Savings Bank.
 Geo. Hull Porter, Western Electric Co.
 Jos. H. Kuhns, Republic Rubber Co.
 Frank A. Buckley, F. A. Buckley Co.
 Fred S. Hickey, Dearborn Chem. Co.
 W. E. Kelley, Patton Paint Co.
 W. B. Hall, Union Ry. Equipment Co.
 J. B. Forsythe, Forsythe-Harding Paper Co.
 J. Will Johnson, Pyle Nat. Elect. Heat-Light Co.
 Geo. Royal, Nathan Mfg. Co.
 C. B. Royal, Standard Oil Co.
 Geo. H. Bryant, Thos. Prosser & Son.
 Jno. Ball, C. & N.W. Ry.
 Jos. W. Taylor, Sec. Western Ry. Club.
 W. A. Bendfell, Western Electric Co.

The friends of members are cordially invited to attend this meeting and the entertainment committee promise several unique thrillers that have never been attempted before.

*Extract from the Journal of the Association of Engineering Societies.

UNION PACIFIC TREATING PLANT AT TOPEKA.

Situated at Topeka, on the Union Pacific R. R., is a treating plant which has at different times been operated in three different locations, at widely separated points.

The plant was originally built as a portable one, and has two cylinders 118 ft. by 6 ft. 2 in., of $\frac{5}{8}$ -in. plate. The housing for the cylinders, etc., is corrugated iron, so that this part of the plant was also portable.

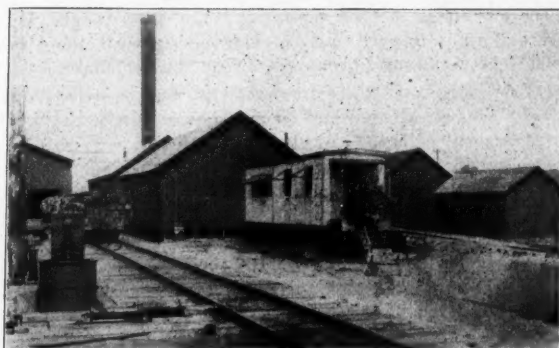
The timber treated at Kansas City is old southern pine, loblolly, long and short leaf. Unloading and loading is done by hand; until recently the labor was all piecework, but now the laborers are paid on a straight day wage basis. The tie yard is filled up and emptied in rotation as far as possible, i. e., ties are unloaded from track No. 1 until the space is filled up; then track No. 2 is used to unload from, etc. The oldest treated ties, in like manner, are always shipped out first. Ties are inspected on receipt at the plant, but there is little sorting to be done, as the timber is all the same species. However, the timbers are sorted for treatment into the three classes mentioned.

The tie yard consists of seven tracks about 2,200 ft. long, connected to a ladder track at one end only. The tracks are stub end at the opposite side of the yard. Four stacks of ties are piled between tracks. This layout is effective for this size and capacity plant, although a second ladder track would facilitate operation. The capacity of the yard is 900,000 ties.

The section men look after the cutting of weeds in this yard, and wood chips are picked up every day, thus keeping the yard free from material which would promote fungus growth. Ties are barked when received, and the bark must also be cleaned up each day.

The ties are seasoned by air, always, if possible, and then are subjected to steam seasoning. However, it is not always possible to keep up with the demand, and sometimes it becomes necessary to treat green timber, i. e., timber which has not been air seasoned.

The amount of rot which develops during seasoning in ties piled close together, subject to a moist atmosphere, depends very largely upon the species and the relative amount of heart and sapwood as well as upon the temperature of the air. Under general conditions, such as are found at Topeka, Kan., the indications are that the amount of decay is extensive. To reduce the moisture content of the wood, and prevent decay in seasoning, the timber is piled



Union Pacific Treating Plant at Topeka.

so as to permit free access of air all around it; in this way the moisture content of timbers of certain sizes can be reduced to about 15 or 18 per cent.

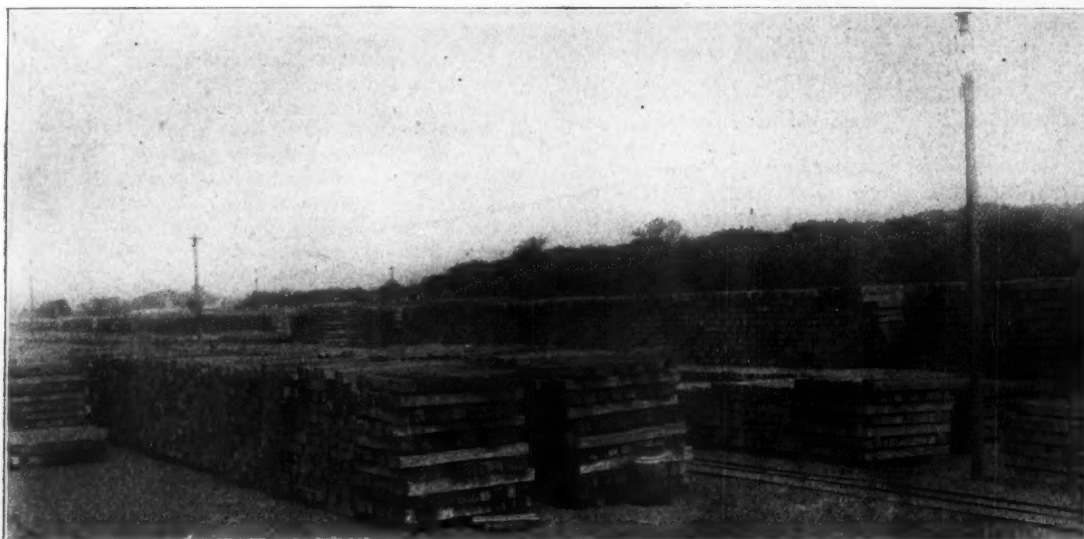
At Topeka the conditions, as far as humidity and altitude are concerned, are quite the opposite from those in the North and West. The humidity, due to damp soil and temperatures that are high most of the year, is very great in this yard. Therefore, every means is employed to separate the ties and allow as much air between the piles as possible.

The cylinders will take a charge of 14 trams, which makes an average charge of from 460 to 470 ties of the large 7"x8"x9" ties which are being used by the Union Pacific.

Zinc chloride is used as a preservative, and an average of $\frac{1}{4}$ lb. of zinc chloride per cu. ft. is injected. The ties are steamed for $2\frac{1}{2}$ hours to 3 hours. The steam from the first retort is blown into the second as far as possible. The vacuum is applied after steaming and the withdrawal of the moisture is watched carefully on the gage.

A $1\frac{1}{2}$ per cent solution is used, and pressure applied from $1\frac{1}{2}$ to 2 hours, increasing the pressure up to a maximum of 100 lbs. The zinc chloride is analysed at the plant by a chemist as soon as each consignment arrives. Tests are made constantly on penetration, a typical test on a southern pine tie being as follows:

The solution tanks at this plant have been in use for over 10 years and are only $\frac{1}{4}$ in. thick and have not corroded excessively at any point.



Tie Yard, Topeka Plant.

The pressure and vacuum in the tank is controlled by a combination pressure and vacuum pump. The pump is changed from suction to a pressure by merely changing the valve.

The electric current for lighting at the plant is furnished by a 10 k. w. Westinghouse generator. Power is furnished by two 90 H. P. boilers. Coal is unloaded from a trestle, and all coal is received in bottom dump cars, so practically no labor is necessary for unloading. A small machine shop, located to one side of the plant building, takes care of all light repairs.

The plant is exceptionally well located as respects feed water, as it is supplied with treated water from a locomotive water treating plant located at one end of the yard.

AIR-HOLE DEFECTS IN STEEL RAILS.

By W. H. Radcliffe.

It is the exception, rather than the rule, nowadays for a year to go by without new speed records being established in railway circles. Accidents occurring with these high speeds are usually of a particularly serious nature, and although much has been done to anticipate and prevent them, there is still more to be accomplished along these same lines before the element of danger to the traveling public is reduced to a satisfactory minimum.

Among the dangers that have to be reckoned with, none is of a more serious nature and more difficult to anticipate or detect in advance than that of air-holes in the rails. The presence of air-holes in metal weakens it in proportion to the amount of metal which is occupied by the air, and in a rail makes it less able to resist the pounding of the wheels.

Owing to the obscurity and nature of this defect, it is obviously impossible to detect and remedy it under ordinary methods, with the result that railway companies have to depend entirely upon the reputation of the steel company that furnishes the rails for good work, and they, in turn, have to rely entirely upon the care taken by their workers in pouring the rails. Then, too, no matter how careful they may be, or however much is claimed for the advantages of the new method of pouring the rails on end and cutting off a certain length afterward, there is always present the possibility of air bubbles being in the metal mass.

So far as the writer knows, there has been no reliable method up to this time of judging of the presence of air-holes in a rail until it is spiked in position on the sleepers, submitted to the actual working conditions of a railroad, and at the cost of human lives and much money proved to contain them. The past year has been no exception to preceding ones in the number and seriousness of these "too late" tests of steel rails.

With the object of providing a means whereby rails may be tested for air-holes in the factory and thereby prevent any possibility of accidents occurring from this cause while the rails are in service, the writer suggests the following electrical method:

Apply to the ends of the rail a low-voltage direct current, and measure, by means of a reflecting galvanometer, the drop in potential from end to end. This drop in potential is directly proportional to the resistance of the rail, and as the resistance of a perfect rail can be easily computed from its size, it being that of a solid mass of steel of the dimensions given, a comparison of the drops in potential obtained on different rails with that of the standard will show at once their relative resistances.

A rail containing air-holes will have a higher resistance than a perfectly solid one, owing to air being of much higher resistance than iron; consequently, a greater drop of poten-

tial will be obtained from an imperfect rail than from a perfect one.

A rapid, exact and convenient means is thus afforded of determining in advance the actual accident-resisting qualities of a rail for the purpose of passing or rejecting it. Rails tested in this manner could be guaranteed free from air-holes by the steel company supplying them, and under this condition they would be worth more to the trade. It is reasonable to assume that railway companies would be willing to pay more for guaranteed perfect rails than for ordinary ones—enough more at least to cover the expense of the steel company in testing them, for every such effort on the part of railway companies to safeguard the lives of their patrons is a move in that direction which makes for increased patronage, larger profits and general welfare.

BRIDGES OVER NAVIGABLE RIVERS—SOME PRACTICAL CONSIDERATIONS.*

By C. E. Smith.

Bridge Engineer, Missouri Pacific Railway.

The Missouri Pacific Railway crosses a number of navigable rivers in Missouri, Kansas, Illinois, Arkansas, Oklahoma and Louisiana, and maintains 30 movable bridges. The spans vary in length from a 36-ft. deck-plate girder bascule bridge to a swing span 440 ft. in length.

The amount of navigation varies with the locality and with the season of the year. Some of the bridges have never been opened for boats since their construction; some are opened only a few times each year, while others are opened once and sometimes more each day during favorable stages of water and not at all for months during low water periods. On most of these rivers the navigation is notable by its absence, and in no case is there sufficient to afford any comparison between the tonnage passing through a bridge by boat and that passing over the bridge by rail; the latter is always many times, and frequently thousands of times, as great as the former. Notwithstanding the preponderance of rail traffic, however, the boat traffic gets the preference, and where there is necessity of delaying either a train or a boat the Federal Government has ruled that the boat must be given the preference, even though that might mean the stopping of the train.

To illustrate: A few months ago a boat approached one of the bridges a few minutes before the schedule time of a fast mail train, which had been reported to the drawtender as being on time. The drawtender realized that he might not be able to open the bridge, pass the boat and close the bridge without delaying the mail train, so he waited until after the train had passed before opening the draw. The boat suffered a total delay of about 10 minutes; complaint was lodged with the Federal Attorney, who took the matter up with the legal department of the railway company. Upon presentation of the facts to him, he ruled that the only condition under which it would be permissible to hold a boat to permit a train to cross would arise when the train was so close to the bridge that it could not be stopped before crossing. This information was conveyed to all the drawtenders through the local officials and they are held to strict compliance with the orders.

This preference for boat traffic over rail traffic may appear arbitrary at first glance until it is realized that the navigable waterway is the work of the Almighty—somewhat assisted by Uncle Sam—and is the property of the public, while the railroad is the work of mere man and is the property of a soulless corporation.

The rights of the public in this regard are thoroughly safeguarded by Federal enactments.

The most important of these laws with reference to movable

*From Bulletin 150, American Railway Engineering Association.

bridges is the Act of March 23, 1906, sometimes referred to as the General Bridge Act. It provides in brief that no bridge shall be constructed over any navigable waters until after it has been authorized by Congress, and that construction shall not be commenced until maps of the location and plans and specifications have been approved by the Secretary of War and Chief of Engineers; that such a bridge shall be known as a post route and the United States shall have the right without charge to construct and maintain telegraph and telephone lines across the bridge; that equal privileges shall be granted to all telegraph and telephone companies; that all railroad companies shall be entitled to equal rights over the bridge upon payment of a reasonable compensation, the Secretary of War being the judge as to the reasonableness; that the bridge shall not unreasonably obstruct free navigation; that if any bridge unreasonably obstruct the navigation either on account of insufficient height, width of span, or by difficulty in passing through the opening, the Secretary of War shall specify the changes desired and the time within which they must be made; that such lights and signals be maintained as shall be specified by the Secretary of Commerce and Labor; that the draw shall be opened promptly upon reasonable signal; that in the case of a toll bridge the Secretary of War shall specify the rates; that failure to comply with any order of the Secretary of War or the Chief of Engineers be punishable by a fine not exceeding \$5,000, each month to constitute a separate offense, and that the Secretary of War and Chief of Engineers may cause the removal of the bridge at the expense of the owner; that when Congress does not specify a definite time, construction must commence within one year and be completed within three years after the date of authority.

The manner in which the various kinds of movable bridges, piers, as well as spans, must be lighted, is set forth in great detail, with illustrations, in a Bulletin issued by the Department of Commerce and Labor.

The question, "What is a navigable river?" naturally suggests itself. The Federal laws do not afford an answer and there is no competent general ruling in existence, nor does it seem possible that there can be given a satisfactory definition. Particular streams or parts of streams have been and may be declared navigable by Acts of Congress, by rulings of the War Department or by courts of competent jurisdiction.

Definition given by a Federal attorney is, in part, as follows:

"A navigable stream is one that can be navigated by power boats."

Definition given by an engineer officer is as follows:

"A navigable stream is one which in a state of nature does or is capable of carrying commerce in the manner in which commerce is usually carried."

After a search of several years the writer has concluded that the following general definition is as good as any:

"A navigable river is one that has been declared navigable by competent authority or that is, in fact, navigable at any time by any boat or raft."

In applying this definition to any particular case the rule of reason must be applied.

In addition to the general laws governing movable bridges over navigable rivers, the War Department issues rules and regulations to govern the opening of bridges, the rules and regulations varying as may be necessary to meet local conditions.

All rivers that are designated as navigable rivers are not navigable in fact, nor does the War Department require the construction of movable bridges over all so-called navigable rivers. A notable example of this is the Kaw river, which joins the Missouri river at Kansas City, Kan. The Kaw river has been declared a navigable river, the Government has established harbor lines for quite a distance above its mouth and has ordered the reconstruction of a large number of bridges to provide increased height, width and depth of foundations, the latter to do away with the necessity for protecting former piers with riprap. In a distance of five miles above its mouth the Kaw is crossed

by 15 bridges, none of which have movable spans. With a few exceptions, the underclearance of the steelwork, after the reconstruction of the low bridges, will be only a few feet above high water level, effectually preventing navigation at high water which would otherwise be prevented by the swift current. At extreme low water the clearance under the bridges is about 30 ft. and the depth of water hardly sufficient to float a small barge. An occasional sand barge uses the river at occasional favorable stages and that constitutes the navigation. The jurisdiction of the War Department over the river is absolute, however, and the reconstruction of bridges now under way to comply with Government requirements will cost several millions of dollars. The example is cited here simply to call attention to the reasonableness of the United States Engineers in not demanding movable bridges to accommodate a small amount of navigation. In fact the result of the writer's negotiations with them indicates the uniform reasonableness of the Engineer Officers in their interpretation of the laws and rules relating to navigable rivers.

Although theoretically it is the duty of the railway company to maintain watchmen and turning machinery at each of its movable bridges and to be always ready to open a bridge at a moment's notice, it is practically unnecessary to bear such expense continuously at bridges that are seldom or never opened. At such points it is customary to lay the rail continuous over the bridge, to set the end wedges (and swing span) so that the draw will not tip under traffic, and to dispense with watchmen. When such bridges must be opened it is customary for the boat owner or master to notify the section men, or nearest local agent, who arrange to open the bridge or to secure the necessary help. The relations between the railway company and the boatmen at such places have invariably been harmonious, as such relations usually promote the interests of both parties.

Occasionally, however, a boat owner approaches a drawbridge over such a stream with the apparent expectation that the railway employees are standing on their toes to serve him, even though his may be the first boat at that point in years and his arrival unexpected. He is one of the common people, surveying and using his inalienable property, the navigable river, which he finds so unreasonably obstructed by the railway company's bridge. His presence in our midst, as it were, is usually first discovered by the section gang or by a crew on a passing train, in which latter case the sectionmen are sent to investigate. The opening of the bridge soon follows. In such cases there is usually a claim for damages, actual and punitive, and plenty, for the delay to the boat, and the railway company settles outside of court if the boat owner can be prevailed upon to see his loss, if any, in a reasonable light. An unreasonably large claim for one day's delay at a bridge that had not been opened previously for six years is now being adjusted.

Another fruitful source of complaint is the presence of stubs of old falsework piling in the channel. These are sometimes left in by the contractor cutting the piles off at extreme low water, assuming that boats cannot use the river until the water is deep enough over the pile stubs to float the boats, or by breaking the piles off, presumably at the bottom of the river, but frequently higher, or they are the remaining stubs of piles that may have been swept away by flood and driftwood, or portions of some former bridge. Whatever may be the reason for their presence, it is practically certain that sooner or later a boat will hit them and they will result in delay or damage or both, with resulting claims. It is the practice of the writer in all cases to insist on the pulling of all falsework piles and former pile piers that stand in navigable channels and this requirement is clearly set forth in the specifications and carefully watched.

It occasionally happens that navigation develops in a stream over which a bridge with simple spans has been maintained for many years. In many cases such bridges must be reconstructed as movable bridges, but in others the necessity for permitting boats to pass occurs so seldom that when the design of the

bridge permits, the most economical solution is the occasional temporary raising or removal of a span by means of a derrick car. There are many bridges that have been opened in this manner for years.

At bridges that are seldom opened, but where watchmen are maintained, it is difficult to maintain discipline on account of the monotony. The watchmen frequently leave the bridge between trains for shooting or fishing trips, with consequent delays to boats and subsequent complaints.

It is also, under the law, clearly the duty of the railway company to maintain channels under movable spans or to maintain movable spans over channels. It frequently happens, after a movable bridge has been constructed over the then channel, especially in a stream subject to quick rise, swift flow and shifting of sandy bottom, that the former channel under the movable span will fill up and a new channel be formed under one of the fixed approach spans. When this takes place it becomes a very nice problem to determine what course to pursue.

In the construction of the Illinois Central bridge over the Missouri River near Omaha, Neb., the channel moved out from under the original draw span while it was under construction. The company immediately arranged for the construction of a second draw span, duplicate of the first, to span the remainder of the river, so there are now four draw openings.

For a somewhat similar reason the bridge of the St. Louis Southwestern Railway over the Arkansas river, near Pine Bluff, Ark., has two draw spans.

The problem of maintaining a movable span over the channel has been simplified by the recent development of the vertical lift bridge. With this type of bridge it is practicable to cross a river with a number of simple spans of equal length on ordinary piers. The towers, counterweights and lifting mechanism are first applied to the span over the channel; at any later date the lifting apparatus may be moved to lift any other span under which the channel may be and the cost of the change will be only nominal as compared to the cost of changing any other type of movable bridge for a similar purpose. A bridge designed with this idea has recently been completed across the Arkansas river between Fort Smith and Van Buren, Ark. There are nine spans 196 ft. in length, the lift bridge being of the Waddell and Harrington type.

In the construction of a new bridge or the reconstruction of an old bridge over a navigable river one of the first steps and frequently the most important step is the negotiation with the United States Government.

In the case of reconstruction it is necessary to look up the authority under which the original bridge at the location was built. This is sometimes in the form of a very general power conferred by the State, in the charter of the railway, or by a special statute, or in the form of a special Act of Congress. When the navigable portion of a river lies wholly within one state the authority of the state is recognized by the Federal Government and the United States engineer officer consents to receive and consider the plans. In other cases the state authority is recognized as sufficient to cover the original construction, but a new special Act of Congress is necessary before plans for reconstruction will be considered or approved.

The rules of the War Department require that when plans and specifications of a proposed bridge are submitted to the engineer officer they must be accompanied by a map showing the river lines one mile above and one-half mile below the proposed crossing, together with cross-sections of the river at frequent intervals. The three points that are given the most attention by the War Department are:

- (a) Location of crossing.
- (b) Location of movable span in the bridge.
- (c) Clear width of channel opening.

When the proposed bridge is to replace a former bridge which has been easily passed by boats and in regard to which there have been no complaints from the river interests, the ap-

proval of the engineer officer is usually merely a matter of form. Where boats have had difficulty in passing through the opening, or where there have been complaints for other reasons, or in the case of a bridge in a new location, the engineer officer either corresponds with the interested parties or holds a public hearing to determine what provisions must be made for navigation.

From the standpoint both of the railway company and of the War Department it is most desirable that a movable bridge be located in the longest possible straight reach of the river, but there are frequently conditions that impel the railway company to choose a crossing at a less desirable location. Where a bridge is located near or at a bend in the river, the boat owners and the War Department usually demand a larger opening than would be demanded in a straight reach. To illustrate: Two drawbridges were constructed over the Black river in Arkansas in 1911. The bridge near the mouth has a draw span 267 ft. long, providing openings 118 ft. wide in the clear, which is ample on account of the straight river, while the other bridge, about 100 miles from the mouth, has a draw span 440 ft. long providing openings about 200 ft. wide in the clear, which is necessary on account of being located in a sharp bend.

The width of opening and location of channel are matters the determination of which frequently takes many conferences and much time.

It frequently happens that on account of Congress not being in session or on account of delays caused by routine, it is not possible to get an Act of Congress passed as soon as it is desired to start construction. In such a case, if the matter is taken up in the proper manner with the Engineer Officer and the wishes of the War Department are fulfilled, the Secretary of War will express the satisfaction of the Department with the plans and state that no action will be taken by the Department if work be commenced at once, the passage of the Act and formal approval of plans to follow. Such permission to proceed usually takes the following form:

"I beg to inform you that while the War Department is without authority at this time to take any affirmative action toward approving plans for a bridge over this river in the absence of proper legislative authority for its construction, it will consider such plans as the company may desire to present now and take such action thereon as may be practicable under the circumstances in furtherance of the company's wishes, but such action would at most be limited to a waiver of interference by the Department with the work, provided the plans make ample provision for the accommodation of navigation at the locality."

It will be seen that even during the construction or reconstruction of a bridge the rights of navigation must be respected and it is the duty of the railway company to maintain navigation or to pay damages that are incurred by private parties if the channel be obstructed. Each case must be handled on its merits, controlled by local conditions such as actual and relative amounts of rail and boat traffic. In the case of very heavy traffic lines it is preferable, where practicable, to change alignment when such bridges are reconstructed in order to avoid interference with either class of traffic. In congested districts this is frequently impossible and it becomes necessary to reconstruct in the former location under traffic. On light traffic lines interference with trains can be avoided without much increase in cost so that the extra cost of changing the location is seldom warranted and it is most economical to reconstruct in the former location under traffic.

The writer has heard that in the past there were instances of navigable rivers having been declared closed for specified periods by the chief of engineers or Secretary of War or by Congress, but it is the invariable practice at the present time

to refuse permission to close the channel even for a short period. It might be possible at the present time to secure the passage of an Act of Congress closing a river to navigation during a specified period for the reconstruction of a bridge, but it would probably be against the recommendation of the War Department and consequently would require more powerful political influence than most railways can command or would care to use for such a purpose if available.

When the War Department is requested to close a navigable channel for a period during reconstruction reply is invariably received somewhat as follows:

"In reply to your letter of the 8th ult., in regard to the reconstruction of your bridge No. — over the — river near —, —, in which you request permission of the War Department to close the channel, I have been authorized by the chief of engineers to inform you that while the Department is without power to authorize the closing of a navigable stream to navigation no objection will be interposed to the proposed work during the period mentioned, it being understood that your company may be liable for any damage sustained by navigation interests by reason of its operations."

It becomes practically necessary to work out a method of reconstruction that will not obstruct navigation or to pay the damages that are incurred by private interests. The United States Engineer Officer will usually make arrangements, if possible, to keep Government boats away from the bridge, if request be made, for a reasonable period, but this is not always possible. It has been the uniform experience of the writer that the Engineer Officers are ready to make reasonable sacrifices where practicable, to avoid interference with the bridge construction.

It was the practice of many railways in the past (and the practice still obtains on some roads) to compel the Contractor to work out a method of taking care of navigation and to make him responsible for any damages arising out of delays or injuries to boats during construction. This practice was objectionable for several reasons—bidders would not familiarize themselves sufficiently with local conditions to be able to make a close estimate of the probable cost to which they would be put in caring for navigation; consequently a sum based on a guess would be added to the bid. In case the sum was too large the railway company would pay for more than it was getting; if too small the contractor would soon find it out and would make every effort to keep within his estimate, with consequent delays to boats and dissatisfaction among their owners.

It is well to realize that the Railway Company must pay for the delays to navigation or for the means to avoid delays, and that it is better to pay the actual amount in either case than to gamble on it by getting an estimate. It is not difficult to write the specifications covering any specific case in such a manner that the contractor will not be subjected to a hardship or forced to take an unreasonable profit.

There are many other ways of taking care of navigation during construction, each case presenting an entirely different problem, the solution of which depends on local conditions.

On the Missouri Pacific Railway it is the practice to let separate contracts for (a) substructure; (b) fabrication, and (c) erection of each bridge.

It is an invariable practice of the writer to design the substructure of the new bridge in such a manner that, whether it be a new location or renewal, the foundation can be put in and completed without stopping navigation. Provision is then made in the specifications that the Contractor's work must be carried on in such a way as not to interfere with boats and he is held to strict compliance with that provision. Considerable contraction of the channel is usually possible during construction for the reason that the boats are much narrower than the channel. the

greater width being required to provide for free passage under all conditions.

The method of erection that will be followed is worked out and described in detail in the specifications. Erection is usually let on a tonnage basis, the price including putting in and taking out the falsework. If any special arrangement of falsework is necessary, such as the installation of a girder span on pile piers, the bidders are requested to name a price for making the special arrangement. Bidders are also requested to name a unit price for each time the bridge must be opened during the erection to permit the passage of a boat. The specifications also provide that during erection the Contractor's work must be carried on in such a manner as not to interfere with boats.

Since the above method of handling has been adopted very little trouble has been experienced in taking care of navigation and few complaints of delays have been received.

Personals

Operating.

I. L. Hibbard, formerly general superintendent, has been appointed acting general manager of the Atchison, Topeka & Santa Fe Ry., Coast Lines, office at Los Angeles, Cal., succeeding A. G. Wells. J. R. Hitchcock, formerly superintendent, has been appointed acting general superintendent at Los Angeles, succeeding Mr. Hibbard, effective March 5. J. A. Christie, formerly trainmaster, has been appointed superintendent at Needles, Cal., succeeding R. H. Tuttle, transferred, effective April 3. E. Dowling, formerly trainmaster, has been appointed superintendent at Dodge City, Kan., effective April 1. D. Elliott has been appointed superintendent at Amarillo, Tex. J. B. Galivan, formerly trainmaster, has been appointed acting superintendent at San Bernardino, Cal., vice J. R. Hitchcock, promoted, effective March 5. R. H. Tuttle, superintendent, was transferred from Needles, Cal., to Winslow, Ariz., April 3, succeeding E. J. Gibson.

D. F. Kirkland has been appointed superintendent of the Atlanta, Birmingham & Atlantic R. R. at Manchester, Ga., succeeding C. B. Wilburn, effective April 15.

J. H. Brinkerhoff, formerly superintendent Illinois Central R. R., has been appointed general superintendent of the Belt Ry. of Chicago, office at Chicago.

H. J. Curry, formerly trainmaster, has been appointed superintendent of the Boston & Albany R. R. at Beacon Park, Allston, Mass., effective April 7.

R. W. Stevens, formerly superintendent of the Belt Ry. of Chicago, has been appointed superintendent of the Chicago & Western Indiana Ry., office at Chicago.

E. Clemons, formerly superintendent, has been appointed general superintendent of the Chicago, Milwaukee & St. Paul Ry. at Seattle, Wash. F. G. Hill, formerly trainmaster, has been appointed superintendent at Mobridge, S. D. C. H. Marshall has been appointed superintendent at Marion, Ga. J. F. Richards, superintendent, has been transferred from Mobridge, S. D., to Tacoma, Wash., succeeding E. Clemons. W. J. Thiele, formerly trainmaster, has been appointed superintendent at Minneapolis, Minn., succeeding F. H. Myers. F. E. Willard, formerly trainmaster, has been appointed superintendent at Missoula, Mont., succeeding C. H. Marshall.

T. H. Beacom, formerly assistant general manager of the third district, Chicago, Rock Island & Pacific Ry., has been appointed assistant general manager of the first district, office at Des Moines, Ia. He succeeds F. J. Easley, who has been appointed assistant general manager of the third district in place of Mr. Beacom. The above change was effective April 1.

A. T. Abbott, superintendent of the Chicago, Rock Island & Pacific Ry., has been transferred from the Iowa division to the

Des Moines Valley division, office at Des Moines, Ia. E. J. Gibson, formerly superintendent Atchison, Topeka & Santa Fe Ry., has been appointed superintendent of the Iowa division, succeeding Mr. Abbott, office at Des Moines. Both appointments were effective April 1.

M. J. Kelley, formerly superintendent of the Illinois Southern R. R., has been appointed superintendent of the Chicago, West Pullman & Southern Ry., office at Chicago.

L. W. Baldwin, who was appointed superintendent of the Illinois Central R. R. at Louisville, Ky., as announced in the April issue of *Railway Engineering*, graduated from Lehigh University in 1896, and immediately entered the service of the Illinois Central R. R. as chairman, and was later promoted to assistant engineer at Memphis, Tenn. He was employed on preliminary survey on the Ft. Dodge & Omaha R. R., and after this work was finished was appointed track supervisor at Springfield, Ill. In 1901 he was promoted to roadmaster at Memphis and transferred in the same capacity to Water Valley, Miss., in 1902 and to New Orleans in 1903. In 1905 he went to Indianapolis to complete the work on the Indianapolis Southern R. R., and was made superintendent of the road in 1906.



L. W. BALDWIN, Superintendent
Illinois Central R. R.

He was transferred to Greenville, Miss., as superintendent Y. & M. V. Ry. in 1908. In 1910 he was appointed engineer maintenance of way I. C. R. R. and Y. & M. V. Ry. at Chicago, and on April 1, 1913, he was appointed superintendent of the Kentucky division at Louisville.

J. H. Rightmeyer has been appointed superintendent and car accountant of the Kentucky & Indiana Terminal R. R. at Louisville, Ky., succeeding T. H. Hayden, effective April 15.

The offices of J. B. Austin, Jr., superintendent, and H. W. Thornton, general superintendent of the Long Island R. R., have been moved from Long Island City to Jamaica, N. Y., effective April 21.

H. W. Sheridan, formerly general superintendent of Morgan's Louisiana & Texas R. R., has been appointed vice president and general superintendent at New Orleans, La.

J. M. Shea has been appointed superintendent of the Norfolk Southern R. R. at Norfolk, Va., succeeding R. S. Anderson, effective April 3.

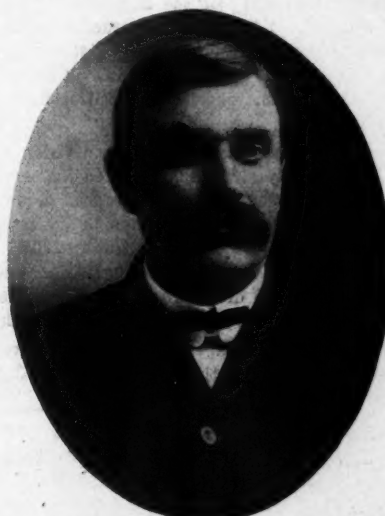
F. R. Blunt, formerly superintendent of the Missouri, Kansas & Texas Ry., has been appointed general manager of the Palacios, San Antonio & Pecos Valley Ry. at Yoakum, Tex.

S. A. Cherry has been appointed superintendent of the Tennessee Central R. R. at Nashville, Tenn.

Ira L. Burlingame, who was elected general manager of the Terminal Railroad Association at the last meeting of the board of directors, held in St. Louis on April 14, has spent his entire life in railroad operation. He was born in Franklinville, N. Y., in 1862, and entered railway service at the age of 17 years, with the Ohio & Mississippi R. R., in the capacity of telegrapher. After a few years he was made train dispatcher, and with the absorption of the O. & M. by the B. & O. S. W. R. R. he was advanced to trainmaster. He entered the service of the Terminal Railroad Association of St. Louis in 1903 as assistant superintendent, and in March, 1904, was advanced to superintendent. In 1905 he was made general superintendent, and continued in that position and title until April 14, 1913, when he was elected general manager.

Engineering.

R. A. Rutledge, who has been appointed engineer of eastern lines, Atchison, Topeka & Santa Fe Ry., as announced in the April issue of *Railway Engineering*, graduated from Kansas University in 1891. He entered the service of the Gulf, Colorado & Santa Fe Ry. in 1892 as rodman; from 1893 to 1896 he was city engineer and city clerk of Florence, Colo., and in 1896-



R. A. RUTLEDGE, Chief Engineer Eastern System.
Atchison, Topeka & Santa Fe Ry.

1897 was deputy United States mineral surveyor, Cripple Creek, Colo. In 1897 he re-entered the service of the Gulf, Colorado & Santa Fe Ry. as instrumentman at Temple, Tex. In 1897-1900 he was assistant engineer in charge of main line reconstruction, and yard construction, and was transferred to Cleburne and Beaumont, Tex., during 1900-1903. In 1904 he was for two months roadmaster on the 4th district, northern division, and was made resident engineer on the Beaumont division in October. He was transferred to Temple, Tex., as resident engineer in April, 1907. In June, 1908, his jurisdiction was extended to cover also the Galveston and Beaumont divisions. In November, 1909, he was transferred to the Northern division with headquarters at Cleburne, Tex. On January 1, 1910, however, the department was reorganized and he was made engineer of the grand division covering all the Gulf lines of the Santa Fe. This position he filled until April 12, 1913, when he was appointed chief engineer eastern lines of the Atchison, Topeka & Santa Fe Ry. at Topeka.

F. M. Bisbee, formerly engineer of western lines, has been appointed chief engineer, western lines, of the Atchison, Topeka & Santa Fe Ry., at Amarillo, Tex. H. W. Wagner, formerly principal assistant engineer, has been appointed engineer of western lines succeeding F. M. Bisbee, office at La Junta, Cal. R. J. Gatewood, division engineer, has been transferred from

San Marcial to Las Vegas, N. M., succeeding T. A. Williams, effective April 20. W. J. Lank, division engineer, was transferred from Clovis to San Marcial, Tex., also effective April 20, succeeding R. J. Gatewood.

J. W. Walter has been appointed acting division engineer of the Atchison, Topeka & Santa Fe Ry. at Clovis, N. M. He entered the service of the Santa Fe in 1902 as chainman at Pueblo, Colo. He was appointed rodman in 1904, transitman in 1906, and assistant engineer in 1907. In 1909 he was appointed resident engineer of the Cloeman Lubbock line, which position he held till in 1912, when he took charge of the Texico Lubbock line. He held the latter position till March 18, the date of his appointment as acting division engineer.

A. F. Nichol, division engineer of the Atlantic Coast Line R. R., has been transferred from Florence, S. C., to Gainesville, Fla., effective April 1.

Mr. Albert D. Case, who has been appointed engineer of structures on the Boston & Albany R. R., graduated from the University of Maine in 1904. He was in the employ of the American Bridge Co. as draftsman for a few months. For the next five years he was with the Erie R. R. in the office of the 1909 he entered the employ of the Boston & Albany R. R. as engineer of bridges and buildings, as structural draftsman. In draftsman in the office of the engineer of structures, and in a short time was appointed assistant engineer in charge of bridge and masonry design, remaining in this position until his promotion above mentioned.

D. Hillman, who has been appointed a division engineer of the Canadian Pacific Ry., lines east, entered the service of that company in 1901. He has been employed on survey and construction, holding positions of chainman up to assistant engineer, being appointed to the latter position in 1905. In 1912 he was appointed assistant engineer of construction, and on April 1, 1913, he was appointed division engineer in charge of double tracking and grade revision work on the Lake Superior division.

H. A. Chandler has been appointed division surveyor of the Canadian Pacific Ry., Atlantic division, at St. John, N. B., effective March 1.

L. J. Carmalt, formerly engineer maintenance of way of the New York, New Haven & Hartford R. R., has been appointed chief engineer of the Central New England Ry.

P. J. Watson, assistant engineer of the Chicago & Alton Ry., has been transferred from Springfield to Atlanta, Ill., effective April 10.

G. M. Rice has been appointed division engineer of the Chicago, Milwaukee & St. Paul Ry. at Spokane, Wash., succeeding A. G. Holt, promoted.

W. L. Arbuckle has been appointed assistant engineer maintenance of way of the Cleveland, Cincinnati, Chicago & St. Louis Ry., at Wabash, Ind. He succeeds L. B. Elliott, assistant engineer maintenance of way, who has been transferred to Indianapolis, Ind. Mr. Elliott succeeds H. E. Woodburn, assistant engineer maintenance of way, transferred to Mt. Carmel, Ill., vice R. B. Smith.

George E. Boyd, who was appointed division engineer of the Delaware, Lackawanna & Western R. R., April 1, was born at Roseville, Ill., February 26, 1874. He was educated in the public schools and graduated from Illinois University in 1896, civil engineering course. He entered railway service as rodman on the Illinois Central R. R. in 1897, and was promoted to instrument man on construction in 1898 and resident engineer on construction in 1899. He was appointed assistant engineer on maintenance in 1901, and in 1903-4 was assistant on grade reduction work. In March, 1904, he was appointed roadmaster, and retained this position till 1911, at which time he entered the service of the Delaware, Lackawanna & Western R. R. as superintendent of bridges and buildings. He was appointed division engineer April 1, with office at Buffalo, N. Y.

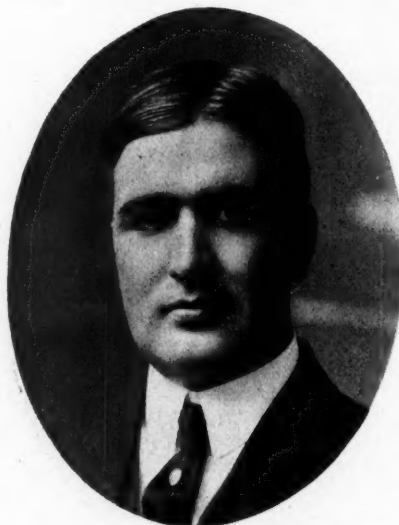
C. E. Wickham, division engineer of the Delaware, Lackawanna & Western R. R., has been transferred from Buffalo to Binghamton, N. Y.

N. Cadarette, assistant engineer of the Duluth, South Shore & Atlantic Ry., has been transferred from Marquette, Mich., to Duluth, Minn.

J. Walker has been appointed assistant engineer of the Grand Trunk Ry. at Allendale, Ont. W. Walker has been appointed assistant engineer at Ottawa, Ont.

C. M. Nye has been appointed principal assistant engineer of the Great Northern Ry. at St. Paul, Minn. O. S. Bowen, resident engineer, has been transferred from Spokane to Seattle, Wash., succeeding R. L. Beaulieu. Both appointments were effective May 1. P. S. Herwin, resident engineer, has been transferred from Minot, N. D., to Great Falls, Mont. H. S. Wollan has been appointed resident engineer at Superior, Wis.

Daniel J. Brumley, who has been appointed engineer maintenance of way of the Illinois Central R. R., as announced in the April issue of *Railway Engineering*, was born March 19, 1865 near Belmore, O. He graduated from Ohio University in 1895,



W. D. MANCHESTER, Chief Engineer
Manistee & North Eastern R. R.

College of Civil Engineering, and entered the service of the Louisville & Nashville R. R. the same year as assistant section foreman. In 1896 he was appointed assistant engineer of the Columbus & Hocking Coal & Iron Co., and later in the year was appointed assistant supervisor of the Louisville & Nashville R. R. at Belleville, Ill. He held successively the positions of section foreman, rodman and assistant engineer till 1901, when he was appointed roadmaster of the Mexican National R. R. at Louisville, Ky. Later in the same year he was appointed roadmaster of the Illinois Central R. R. at Elizabethtown, Ky., and in 1904 was appointed division engineer of the Indianapolis Southern Ry. at Indianapolis, Ind. He was appointed assistant chief engineer of the Illinois Central R. R. and the Yazoo & Mississippi Valley Ry. in 1905, and engineer of construction in 1910. He held the latter position till April 1, 1913, the date of his appointment as engineer maintenance of way.

F. L. Thompson, who was appointed engineer of construction of the Illinois Central R. R. April 1, as announced in the April issue of *Railway Engineering*, graduated from Illinois University in 1896, College of Civil Engineering. He entered the service of the Illinois Central R. R. in 1896 as chainman on the lowering of tracks on the lake front at Chicago. From 1897 to 1908 he held the positions of rodman and assistant engineer on construction, grade reduction, and surveys. He was placed in charge of double tracking and grade reduction from Irvington

to Carbondale, Ill., as assistant engineer in 1900, and was transferred to the chief engineer's office in a similar capacity in 1902. In 1903 he was made acting roadmaster, Chicago division, and in 1903 roadmaster of the Louisville division. He was appointed assistant engineer of bridges in 1907 and engineer of bridges and buildings in 1910, which position he held till his recent appointment as engineer of construction.

L. I. Smith has been appointed assistant engineer of the Louisville & Nashville R. R. at Pensacola, Fla., succeeding W. S. Moore.

Mr. William D. Manchester was appointed Chief Engineer of the Manistee & North-Eastern Railroad Co. at Manistee, Mich., April 15, 1913, taking the position made vacant by the death of John J. Hubbell, who had served the company for twenty-six years. Mr. Manchester was born February 17, 1882, at Allenford, Ontario. He attended the high school and Collegiate Institute in the town of his birth, and performed his first railroad work on the Canadian Pacific in 1899 at Owen Sound, Ont. He was engaged in other pursuits from 1900 until 1903, when for about one year he was employed in the train service on the South Side Elevated Lines of Chicago. In 1905 he secured employment with the Manistee & North-Eastern R. R. on construction work. In 1910 he became assistant engineer, and subsequently was in charge of active operations in the field, the company constructing fifty-five miles of road in 1909 and 1910. In 1911 he was called upon to practically assume the duties of chief engineer, owing to the illness of Mr. Hubbell, who died on April 1 of the present year.

B. H. Persons has been appointed office engineer of the Michigan Central R. R., office at Detroit, Mich.

P. Burkholder, formerly division engineer, has been appointed general division engineer of the National Rys. of Mexico, at Mexico, D. F. W. G. Bowen, division engineer, has been transferred from Monclova, Son., to Monterey, N. L. Jose Beltran, assistant division engineer, has been transferred from Guadalajara, Jal., to Mexico, D. F. Aurelio Chavez, assistant division engineer, has been transferred from Gomez Palacio to Durango, Dgo. Vicente Espinosa, assistant division engineer, has been transferred from Mexico, D. F., to Guadalajara, Jal. S. L. Kane has been appointed assistant division engineer at Tampico, Tamp., Mex. E. W. Scott, assistant division engineer, has been transferred from Gomez Palacio to Torreon, Coah.

James E. Crawford, formerly bridge engineer, has been appointed acting chief engineer of the Norfolk & Western Ry., succeeding C. S. Churchill, temporarily assigned to other duties.

Mr. A. J. Wharf was appointed chief engineer of the Peoria & Pekin Union Railway Co., effective April 15, 1913, succeeding W. E. Emery. Mr. Wharf, after graduation at the University of Illinois, went to the Union Pacific R. R. at the beginning of its reconstruction period in 1899, remaining there in capacities from rodman to assistant superintendent, until 1912, at which time he engaged in private work in Chicago, till the time of his appointment mentioned above.

H. P. Bayly has been appointed assistant engineer of the Southern Ry. at Augusta, Ga., effective March 27. O. B. Lackey, assistant engineer, has been placed in charge of construction work, with office at Richmond, still retaining his former office at Spencer, N. C.

H. R. Mamby has been appointed engineer of the Tennessee R. R., office at Nashville, Tenn., succeeding L. F. Lonnbladh, resigned to accept service with another company.

G. H. Smith has been appointed division engineer of the Toledo & Ohio Central Ry. at Bucyrus, O., succeeding D. C. Holtsberry.

Bridges and Buildings.

W. J. Cairns has been appointed supervisor of bridges and buildings of the Grand Trunk Ry. at Lindsay, Ont. W. Cayley has been appointed supervisor of bridges and buildings at Stratford, Ont. George Dyson has been appointed supervisor

of bridges and buildings at Montreal, Que. G. C. McCue has been appointed supervisor of bridges and buildings at Ottawa, Ont. J. McMahon has been appointed supervisor of bridges and buildings at Belleville, Ont. H. R. O'Donnell has been promoted from bridge and building inspector to supervisor of bridges and buildings at Orilla, Ont. N. Tichbown has been appointed supervisor of bridges and buildings at London, Ont. W. H. Tool has been appointed supervisor of bridges and buildings at Allandale, Ont. J. Wilson has been appointed supervisor of bridges and buildings at Hamilton, Ont.

J. R. Gordon has been appointed master carpenter of the Seaboard Air Line R. R. at Richmond, Va., succeeding L. O. Freeman. J. L. Winter, master carpenter, has been transferred from Jacksonville to Waldo, Fla.

E. M. Carter has been appointed supervisor of bridges and buildings of the Tennessee R. R. at Nashville, Tenn., succeeding I. W. McCluen. R. T. Joslin has been appointed general foreman of bridges and buildings at Nashville, Tenn., effective April 1.

New Books

THE DESIGN OF STEEL MILL BUILDINGS. By Milo S. Ketchum. Third edition enlarged. Cloth, 6½x9 in., 562 pages, 66 tables and 270 illustrations. Published by The McGraw-Hill Book Co., New York. Price \$4.00 net.

The new edition of this well known work is considerably larger and more complete, as is natural, than preceding editions. Much of the subject matter is either new or entirely rewritten, making the book an up-to-date and invaluable reference work on steel mill buildings.

The book is divided into four distinct parts, viz.: I. Loads, II. Stresses, III. Design of Mill Buildings, IV. Miscellaneous Structures, and in addition three appendices which are, (1) General Specification for Steel and Frame Buildings, (2) Problems, (3) Structural Drawings, Estimates and Designs.

The first two parts of the book treating loads and stresses, are quite extensive, and compose a large part of the book. Graphical and algebraic methods of stress computations for roof trusses, beams, bridge trusses, portals and hinged arches are given. It seems rather out of place to give so much theoretical matter in a book of this character, especially on bridge trusses, which are not in a strict sense a part of the work at hand. This space could have been used to better advantage by an extensive exposition of the methods and principles to be followed in proportioning and designing the various members of trusses and steel frames, very little of which appears in the book.

The third part of the book on the design of mill buildings is a very valuable descriptive exposition of all those things which enter into the construction of a building of this type. For the designer and detailer whose wants the book is intended to fill, this part is invaluable and has for this reason made the book one of the most useful reference books on the subject, which until recently was the only valuable one of its kind published. Part four is descriptive of miscellaneous structures, such as steel domes, locomotive shops and round houses.

Appendix 1 on general specifications has been completely rewritten and as it now stands is without doubt the most complete and up-to-date set of specifications on the subject to be found. Appendix 2, consisting of problems in graphical statics and the calculation of stresses will be of value to the student and young designer. The third appendix treating of structural drawings estimates and designs, which consists of 78 pages is entirely new and the most important addition to this edition. Giving as it does practical rules for designing and making shop drawings it fills the wants of the student and young designer or draftsman who has not been able to obtain these

things by experience or from other sources. The text is amplified by illustrations of shop details of various kinds. A chapter on estimates of structural steel should prove to be a valuable addition insofar as the young designer and engineer is concerned. Brief instructions on the design of steel structures are next given, followed by a set of 30 tables and structural standards. Material for this appendix was furnished by the various large bridge companies, such as the American Bridge Co., McClintic-Marshall Construction Co., and the Pennsylvania Steel Co., which makes it all the more valuable inasmuch as such information is not available to every engineer.

The book as it now stands should be in every engineer's library, since it sets forth the best modern and accepted practice on this important subject.

ENGINEERING OF SHOPS AND FACTORIES. By Henry Grattan Tyrrell, C. E. Cloth $6\frac{1}{2} \times 9$ in., 399 pages, 174 illustrations. Published by McGraw-Hill Book Co., New York. Price \$4, net.

This new book differs from others on the same subject, in that it treats of the economics of factory location and construction, factory lighting, heating, sanitation and water supply, fire protection and other kindred features, in addition to structural features as treated in other works. It is primarily a book for the Industrial Engineer who makes special studies of the economics of location, construction and operation of manufacturing plants. The fact that the success of many a business depends on the economic arrangement and operation of plant as well as good management has created a place for the industrial engineer among the various other classes of engineers. The day when manufacturing plants were "just built" and not designed in accordance with any principles of economy, is past and Mr. Tyrrell's book is very timely and acceptable for this reason.

The book is divided into 32 chapters treating of, engineers and their services; selection of manufacturing district; economics of factory construction; example of preliminary design; general design; selection of building type; wood and steel framing; concrete buildings; concrete surface finish; cost of reinforced concrete buildings; comparative costs; foundations; ground floors; upper floors; concrete upper floors; wall, partitions and openings; roofs and roofing; special buildings; storage pockets and hoisting towers; factory heating; air washing systems; factory lighting; drainage; water supply and storage; steel chimneys; fire protection; cranes; yards and transportation; estimates; construction; welfare features; and standard buildings and bibliography.

As in his other books, Mr. Tyrrell places emphasis on the aesthetic treatment of the design of factories and their maintenance. This is to be highly commended, for the number of ugly factory buildings is entirely too great. It does not cost much more if rightly handled, to have a building with a pleasing appearance than it does to build one with four walls and a roof and without any thought of appearance entering into the design. All theoretical treatment of stresses and design is very wisely omitted, since by so doing the space has been allotted to many valuable tables for use in design which increases its value as a reference book.

Another feature which must be commended is the amount of space devoted to concrete buildings which are rapidly becoming the standard shop building where permanence and low cost of maintenance are considered. The table of thicknesses of flat slab reinforced concrete floors for various spans and loadings is rather misleading, since it does not state for what system of reinforcing (of which there are several), these tables hold good. It is a well known fact that some of the highly commercialized designs of flat slabs are in many cases "skinned" to such an extent as to make them entirely too dependent on the factor of safety or "ignorance," as it is sometimes called. Engineers with the proper sense of duty for both their clients and the profession will not cut the amount of reinforcement and concrete in a flat slab floor to

a dangerous minimum in order to get the job. It is a fortunate circumstance that those who have not followed this code of ethics are being discredited and the scientifically designed flat slab, and not the commercially designed flat slab, is being more extensively used.

It is to be regretted that steel chimneys alone are treated in this work, it seems that the extensive use of brick and concrete chimneys merits their treatment in a book of this character. The chapters on drainage, heating, air washing and lighting were written by specialists.

The book is well arranged and logically constructed, the typography is excellent, the tables are well arranged, the style is interesting and the grammatical construction and choice of words could be little improved. As companion work to "Mill Buildings," by the same author, (Reviewed in the March, 1913 issue) the book is most valuable.

To the shop owner, manager, architect and to the engineer engaged in the general or structural design of buildings the book is an invaluable asset, and can be read and studied with profit by all concerned.

A HANDBOOK OF ENGLISH FOR ENGINEERS. By Wilbur O. Sypherd, $4\frac{1}{2} \times 7$, flexible leather. Published by Scott, Foresman & Co. Price \$2.50.

The necessity for training engineers in technical writing, is being shown by the increased attention given the subject, resulting in many articles in technical magazines, and also in an increasing number of books issued on this subject.

The author states in the preface that this handbook "is designed primarily for the use of advanced engineering students and young engineers in practice." We find, however, many engineers who are older in experience, whose writings are capable of vast improvement.

Many engineers have a distaste for writing of any kind—be it reports, specifications, or articles for technical societies and magazines. This is a mistake, for a great many of the highest engineering positions require skill in writing. And each engineer will do well to overcome his aversion to writing, and rather evince a keen interest in it. Any engineer, should, at the very least, be able to write a clear, concise, and comprehensive application for a position; further skill will be, and is being sought for, by those engineers who are progressive and overlook no opportunities for their advancement.

The chapters in the Handbook are: (1) The General Problems of Engineering Writing; (2) Mechanical Details Common to the Various Forms of Technical Writing; (3) Business Letters; (4) Reports; (5) Articles for Technical Journals.

Chapter I gives valuable hints and helps for properly planning the forceful and logical written presentation of engineering papers. Paragraphing is rightly made an especially important part of this chapter, and is also frequently dwelt on in the following chapters.

Business letters are becoming more and more necessary in connection with the selling of devices by technical men. The information given will appeal strongly to those who are connected especially with the sale of engineering articles.

The proper use of words is treated briefly and forcibly in Chapter V. The author says in part, "Ideas count for little if a man has not at his command the words which will convey his ideas to others;" and "the essential requirements in words are economy, simplicity, clearness." A discriminating or careless use of words can make or mar a valuable subject.

This book is pocket size, with excellent quality leather cover, and will prove a valuable addition to the library of any engineering employe—both for study and reference.

RAILROAD CONSTRUCTION. By Charles L. Crandall, and Fred A. Barnes, 6×9 , cloth, 320 pages, illustrated. Published by The McGraw-Hill Book Co., New York. Price \$3.00.

This book is designed to fill especially the need for a comprehensive general text book for students on the subject of

railroad construction, and also as a reference work for the young engineer.

It contains a great deal of information gathered from numerous sources, and two features of the book cannot be too highly commended, viz.: (1) The large number of references given at the end of each chapter, by the use of which the engineer interested especially in certain phases of the subject is enabled to find exhaustive information on those particular subjects; (2) The incorporation of unit costs in every case where it was possible to obtain them.

The scope of the work is so broad that no attempt was made to go into great detail, but the manner of presentation, together with the references given, should furnish an incentive toward further investigation.

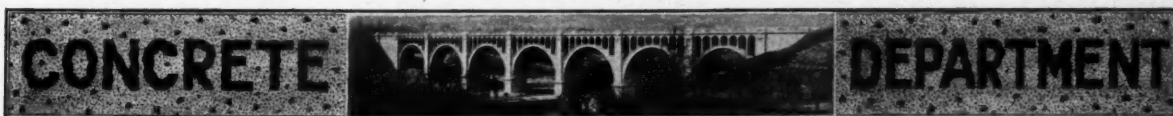
The book includes chapters on Earthwork, Rock Excavation, Tunneling, Masonry, Foundations, Culvert and Bridge Masonry,

Trestles and Bridges, Track Materials and Roadbed, and Estimates and Records.

The chapter on Earthwork deserves special mention on account of the extensive and complete discussion of the many different methods and kinds of machinery used in excavating and building embankments.

Methods of Tunneling are given in Chapter IV, with a large number of examples from both foreign and American practice. This chapter is also comprehensive, giving rates of progress on a large number of projects, with costs and other data.

Those who have been forced to look for information on construction through a large number of pages or volumes, will find this book of value; much data is contained therein in a convenient form and logical arrangement, which the engineer has formerly been forced to keep in his note book.



Shipping Cement In Bulk.

DURING the past year considerable cement shipped in bulk, instead of in bags, as is the usual practice, has been used in construction work near Chicago. In all cases the contractors have agreed that this practice is more economical and just as satisfactory as handling cement in cloth bags. The one great disadvantage in using bag cement has been that the buyer must pay 10 cents for each sack, which is credited to him on return of the sack in good condition. During construction the empty sacks are used for various and sundry purposes by the laborers, which render them unfit for return and credit. As a result, even if an effort is made to account for and keep track of all cement sacks, at an extra expense, considerable money is lost and no small amount of capital is tied up in sacks before they are returned. In railway work, done by company forces, this is especially true. As a general rule the laborers do not care what becomes of the cement sacks, and the foreman has so many other duties to attend to that he cannot give the matter much attention, and as a rule does not try to, even if he does have time. This is because of a general feeling that exists among railway employes caused by the shortsightedness and failure of the directors to establish a merit rule in the advancement of employes. It is, therefore, to the advantage of those concerned to do away with the handling of cement in bags or in other words to have it shipped in bulk.

The question may be raised as to what would happen to cement shipped in a car with a leaky roof. Experience shows that the damage is not as extensive to cement shipped in bulk as it is to that shipped in bags. In the former case the water dripping through the roof forms a little puddle in the cement, the surrounding cement sets and a crust is formed which protects the cement below. When the cement is used this hardened cake is thrown out and the loss is insignificant. If a car of bag cement has a leaky roof, the water trickles down through between the sacks and soaks into the cloth and a portion of several sacks is spoiled. However, this matter of damage by leakage can be stopped by careful in-

spection of cars before loading; cars with roofs in bad order need not be used.

Another point in favor of the use of bulk cement is the time saved, which is ordinarily taken to untie, empty and shake cement out of sacks, to say nothing of the time saved by not having any sacks to take care of, bundle and ship back to the mill.

The dust raised while handling bulk cement is not any more in evidence than when sack cement is used. This may not seem reasonable, but actual experience on work has proven this fact.

From an economic standpoint the bulk shipment is the ideal method of transporting cement, if the size and location of the job is such that the cement will only have to be handled once.

Joints In Concrete Work.

MUCH HAS been written about the proper bonding of successive layers of concrete in walls, piers, columns and foundations, and it is very evident that much of this comment has been misdirected. Some constructors are in the habit of "securing bond" between concrete laid the previous day and the fresh concrete by flushing the surface with water and placing about half an inch of rich cement grout or mortar thereon and then placing the fresh concrete.

That this method is unsatisfactory especially in summer when concrete sets rapidly was pointed out very forcibly to the writer a few days ago while examining a hole cut through a concrete wall poured in September, 1912. This opening was cut in the wall for a doorway and the top of the opening was to be just about $\frac{1}{2}$ inch below a horizontal construction joint. This $\frac{1}{2}$ inch of material was entirely of cement and sand, the top being nearly all cement; the result of the stone settling in the soft concrete, which was mixed quite wet. Most of this material fell out when the hole was cut, and pieces that were still in place were very readily separated from that above by a knife blade. The top of this concrete was very smooth and of a yellowish gray color, a fine example of a combination of

"laitance" (decomposed cement formed in presence of an excess of water) and loam or dirt in sand and stone which had floated to surface. The bottom surface of the concrete (or rather the grout coat, just above, was nearly as smooth as if poured on glass or oiled forms, there being practically no adhesion whatever between the successive layers.

After viewing this joint, any advocate of the "grout joint" method of bonding successive layers of concrete without roughing the previously laid surface would have changed his ideas on the subject forthwith. Photographs, however, even if they could have been taken, would not have shown the true character of these concrete surfaces.

Such a joint as the one just described is a source of weakness in any structure. In a retaining wall of reinforced concrete with a joint of this character in it the water back of wall would seep through the joint and as a result the steel would be rusted and it would not be surprising to see the wall fail if the earth pressure was very great.

The proper way to obtain good joints between successive layers of concrete is to have a dovetail joint along the center of wall and to remove all traces of laitance, roughen the surface of the concrete in a thorough manner, then remove all loose particles of concrete with a brush or better still, with a steam jet. After this place a layer of rich grout on the concrete, then a layer of fresh concrete and tamp the same thoroughly. Such a joint will in most cases give satisfaction, but it cannot be too forcibly impressed on all engaged in concrete work that construction joints require much more attention than is usually given them.

TRUTH IN ADVERTISING NO. 3.

Now that the subject of "Truth in Advertising" is under discussion it might be well to enter into the concrete field, the sudden rise and increased importance of which has given rise to some advertising methods which cannot be considered the best.

The clay interests noting the gigantic strides taken by the concrete industry in this country, have inaugurated an advertising campaign against concrete, which at times borders on the ridiculous. Every possible means of harping the concrete industry and making "capital" out of various happenings in the concrete field, is used by the clay interests. We admit that there has been in the past a considerable amount of poor concrete used in various branches of the industry, i. e., in the drain tile and cement block division. This has in general been due to "patent medicine" advertising tactics of the firms selling block and tile machines and the unscrupulous, get-rich-quick operators buying these machines. Instead of using cement in the proper proportions to make dense and durable mixtures, many have found it cheaper to use sand instead of cement, just enough cement being used to make the tile or blocks stick together. Such things as these are lamentable and have furnished legitimate fuel for the advertising flames of the clay interests.

Pictures of cement pipe and drain tile, (undoubtedly of poor quality at the start), which have not stood the test of time and the elements, are cited as horrible examples of what will happen to all things made of concrete, and given as reasons why clay products should be used. This is manifestly unfair for it means, trying to prove a rule by choosing exceptions as examples.

It can also be said that other interests than the clay interests have been using just such methods in forwarding their own devices. They fail to realize that there is room for all, in the field of competition, and in their eagerness to give con-

crete a "black-eye" they are inviting their own downfall. The well known saying, "Every knock is a boost," holds good in this case, and sooner or later, undoubtedly too late, the adverse interests will become aware of the fact.

It will be of interest in passing to note that on Feb. 12 the Pennsylvania legislature passed a bill unanimously, which prohibits the making or dissemination of false or misleading statements or assertions concerning any merchandise, securities or services. This shows conclusively that there is need of reform in the advertising field, for such measures as the above are seldom enacted until it is absolutely necessary to stop such corrupt practices. Another notable feature of the above mentioned legislation was the fact that a Publicity Association was largely responsible for the action taken, which happily indicates that the majority of advertisers have not allowed the quest for the "Almighty Dollar" to vitiate their sense of honor and blot out the code of ethics which all honest men follow.

EXPANSION AND CONTRACTION OF CONCRETE.

A. M. Wolf.

It is not necessary to set forth any theoretical discussion to show that concrete expands or contracts while hardening and even after it has attained its final set, depending on various conditions of temperature, exposure and quality of concrete (i. e., the mixture). Cracks in retaining walls, abutments, humped-up sidewalks (in summer) shrinkage cracks in cement finishes, and many other demonstrations of this kind show beyond doubt that these two actions take place. To show what all the causes of these destructive forces are is another matter and one which cannot be answered offhand, but one which experiments must be depended upon to answer.

Careful experiments made by Prof. W. D. Pence in 1899 to 1901 at Purdue University led to the conclusion that the coefficient of expansions of 1:2:4 concrete, both with gravel and crushed stone as the coarse aggregate in air due to changes in temperature was about .0000055 per degree Fahrenheit. This value is now taken as the standard coefficient of expansion of concrete in air. Later experiments have established the fact that the temperature changes in concrete are due in addition to external temperature variation, to chemical changes which take place while the concrete is hardening. It has also been found that expansion and contraction of concrete was influenced considerably by the presence or absence of moisture.

The Boonton Dam experiments* and the observations made during the work on the Des Moines River Bridge† show that there is an increase in temperature in the concrete mass after pouring and this increase is of some considerable duration. At the Des Moines River Bridge the increase in temperature in concrete of piers and abutments was from 15 to 20 degrees F. and the maximum was reached in from 7 to 10 days after pouring. There can be no doubt that this increase in temperature is due to the chemical processes of setting and hardening. After this chemical action is spent the concrete mass cools by conduction and radiation; as a result tensile stresses are produced which cause the formation of cracks. At the Boonton Dam, which is a massive concrete dam, the records show that the concrete in the interior cooled very slowly and that the contraction cracks continued to increase in width for several years. No cracks appeared the first winter, but during the second and third winters numerous vertical cracks appeared. These cracks reopened during the fourth and fifth winters after building. Another notable fact brought out was that more cracks developed in that part of the dam in which the concrete was poured during the summer months.

Another cause for contraction is the drying out of the water from the concrete mass, but the amount of this contraction cannot be set down in figures.

*Transactions, A. S. C. E., Vol. LXIII, 1909.

†Railway Engineering, Oct., 1912, p. 476.

As early as 1887 the committee on cements of the A. S. C. E. presented the following conclusions as to the effect of hardening of concrete on the volume, based on experiments by Prof. Bauschinger and Prof. G. F. Swain.

1. Cement mortars hardening in air diminish in their linear dimensions at least to the end of twelve weeks, and in most cases progressively.

2. Cement mortars hardening in water increase in like manner but to a less degree.

3. The contractions and expansions are greatest in neat cement mortars.

Conclusions drawn from tests on neat cement and cement mortars by Prof. Alfred H. White, of the University of Michigan** are given briefly as follows:

Concrete hardening in a moist place and remaining continually moist throughout its life expands slightly, but the

pansion and contraction of concrete decreases as less cement is used, so that it appears that the changes are more a function of the cement than of the mineral aggregate.

The subject has not been studied sufficiently to show how far such factors in the manufacture of cement as chemical composition, temperature of burning, fineness of grinding and rate of setting influence the result; nor how far conditions surrounding its use such as the amount of water, temperature of air etc., affect it. Until the influence of these factors has been determined it will not be possible to make intelligent progress towards lessening the volume changes and increasing the reliability of structures containing Portland cement."

Tests being made by the Office of Public Roads Dept. of Agriculture are the latest additions to the knowledge regarding this subject. Abstracts from a paper read by Logan W. Page before the Ohio State Engineering Society Jan. 24, 1912,

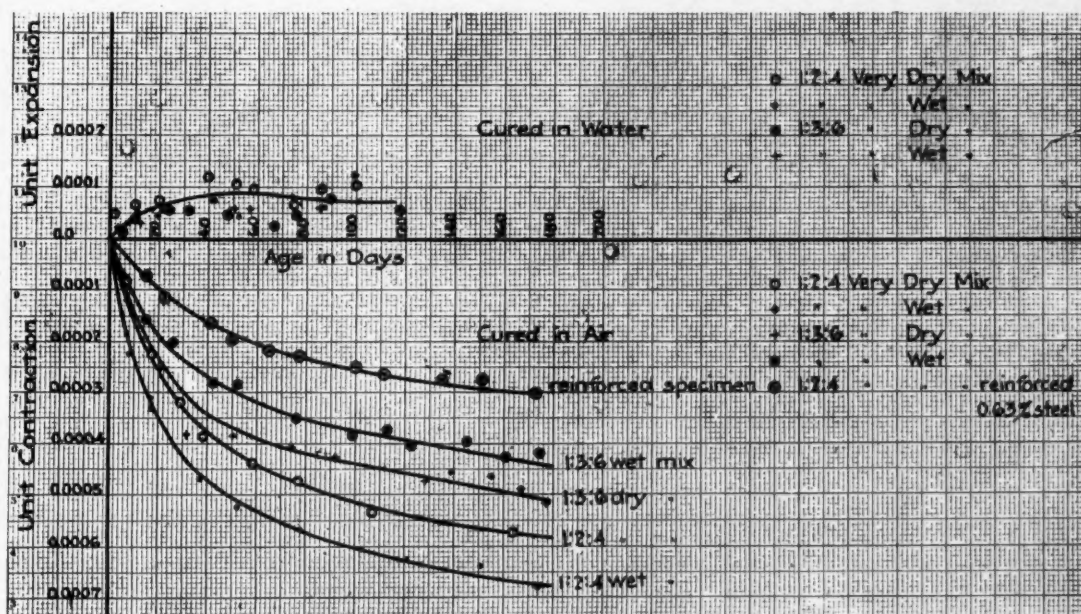


Plate I. Expansion and Contraction of Concrete While Hardening.

compressive stress developed in the concrete is probably not large enough to be injurious.

Concrete hardening in air and remaining dry contracts. The contraction is roughly twice as much as the expansion of concrete that is continually damp. This greater stress is dangerous, both on account of its magnitude and because the concrete is weakest in tension. It introduces an error of unknown magnitude into the calculations for all reinforced beams. It is responsible for the cracks in the top coat of interior cement floors. Fortunately most of the bad effects become evident within three months.

Prof. White gives the following on the causes of change of volume: "The progressive nature of the volume changes of concrete as the cement hardens in water or air makes it evident that they are connected with the chemical processes of hardening. Since the hardening of cement is recognized as being essentially a process of colloid formation and change, it may not be unreasonable to hold that the changes are connected with the volume of the colloid water. The nature of the volume changes as cement changes from the dry to the wet state is in harmony with this view. It is probable that the volume changes are also in part due to purely capillary phenomena, for sandstones and other building stones expand when wet and contract when dry. The amount of the ex-

at Cleveland, give the results of these tests for the first period of six months.

The specimens were made quite large so as to insure more accurate results. These specimens were made in the shape of columns 8 in. square and 5 ft. long, some of 1:2:4 concrete and some of 1:3:6. Standard Portland cement, well graded clean river sand and crushed gneiss were the materials used. The specimens were made of two consistencies, one very wet and the other very dry; the very wet concrete being simply puddled while the dry concrete was tamped into the mold with difficulty. One-half inch square bars were placed fifty inches apart in the specimens, thus projecting $1\frac{1}{2}$ inches on each end of specimens. To these bars steel plugs with rounded conical points were attached by means of a micrometer fitted to a specially designed frame. This apparatus allowed of taking accurate readings to a few ten thousandths of an inch.

As soon as the concrete had hardened sufficiently, the molds were removed and the official readings taken. The temperature of the specimens and that of the air were noted at each reading of the micrometer and all readings were corrected to constant temperature. Consequently the deformations obtained represent the change in length due to the effect of moisture alone, the influence of temperature being eliminated.

The curves of Plate I show the behavior of concrete while hardening under different conditions of moisture. These curves show that concrete like neat cement and mortar ex-

**Paper before Am. Soc. for Testing Materials, 1911.

pands when allowed to harden under water and contracts while hardening in air. It will be noted from the curves that the specimens hardened in air, contracted from the beginning, rather slight at first as shown, however, the major portion of the contraction took place within the first three months and fully 50 per cent of it in the first month. The curves also show that rich mixtures (1:2:4) contract more than the leaner 1:3:6 mixtures. The maximum contraction at the end of six months for 1:2:4 concrete was 0.00068 inch per inch of length.

Plate I also shows the contraction taking place in a specimen reinforced with two $\frac{1}{2}$ inch plain bars, hardening in air. The rods were one inch apart and extended the full length of testpiece. The percentage of reinforcement amounted to 0.63 per cent. The maximum contraction at the end of six months was 0.0003 inch per inch of length, or less than one-half that of the unreinforced specimens, which very forcibly indicates how steel reinforcement decreases the contraction. The steel is undoubtedly under high compression on account of shrinkage of the concrete.

Concrete Hardening Under Water.

The specimens used in the tests under water were first allowed to harden two days in air. They were then measured with the micrometer and then laid on rollers in a horizontal position and immersed in water, the rollers allowing for free expansion. The curve of Plate I above the base line indicates that in every specimen a decided expansion took place. At the end of three months, the specimens still show an expansion which amounts to approximately 0.000075 inch per inch of length—a value from $\frac{1}{4}$ to $\frac{1}{6}$ of the contraction of the same concrete stored in air. After about one month the length of the specimens remained practically constant.

Alternate Wetting and Drying.

Plate II gives the results of measurements of specimens which were kept wet for about two weeks by means of a covering of wet burlap and then allowed to dry out. Just as soon as the specimens dried out they began to contract and the ultimate amount of contraction reached (up to time of presentation of paper) was nearly 0.045 per cent and the contraction was still taking place. When these specimens were again immersed in water they again expanded.

A notable fact shown by the curves of Plate I is that a 1:3:6 concrete mixed very wet and hardened in air contracted less than the same concrete mixed dry and that the reverse was true in the case of a 1:2:4 mixture of concrete. The 1:2:4 mixtures contracted more than the 1:3:6 mixtures as would be expected, due to the higher content of cement which tends to cause greater contraction as shown by Prof White's experiments at the University of Michigan. In the case of the wet mixture of 1:2:4 concrete the fact that the concrete was very wet caused a greater contraction than took place in the dry mixed concrete. It is the usual experience where wet and dry concretes are used, to note that contraction cracks are more numerous in the concrete which was mixed wet which indicates greater contraction in wet mixtures. The tests, however, show that this is not true for the leaner 1:3:6 concrete, the greater contraction taking place in the dry mixture. This seems rather paradoxical and is hard to explain. The points plotted on the curve of expansion for specimens cured in water show that the maximum expansion took place in the dry mix of 1:2:4 concrete and the very wet mix of 1:3:6 concrete, and that the expansion of the wet mix of 1:2:4 concrete and the dry 1:3:6 concrete was about the same, the difference, however, was very much less and not so marked as in the contraction tests. However, it is safe to say, judging from the values obtained and plotted, that the richer mixture of concrete expands more when cured in water than a leaner mixture.

Plate II exhibits more interesting information. The points plotted for the various mixtures of concrete subject to curing

in moisture for 15 days and then allowed to harden in air show that the medium wet mixture of 1:2:4 concrete expanded the most and contracted the least, while the very wet mixture of 1:3:6 concrete did not expand as much as the medium wet 1:2:4 concrete, but contracted more than any of the other specimens. The very dry mixed 1:3:6 concrete expanded almost as much as the medium wet mix of 1:2:4 concrete and contracted almost as much as the very dry 1:3:6 concrete. The very wet mixture of 1:2:4 concrete expanded the least and the contraction was about a mean of that of the medium wet 1:2:4 and the very wet 1:3:6 concrete.

From this it can be concluded that by mixing a rich concrete very wet the expansive tendency when cured in water, caused by the presence of more cement is offset by the excess of water used in mixing. Also that the excess of water used in mixing causes greater contraction than in the specimen of the same rich mixture with less water.

The probable causes of these changes in length were given by Mr. Page as the following: "The formation of colloids or gelatinous bodies by the combination of water with cement is accompanied by an increase in volume over that of the cement in its untreated condition, accounts for some of the expansion. The formation of these colloids is very readily seen by stirring a small quantity of cement with an excess of water and agitating the mixture from day to day. In the course of a few weeks, a jelly like mass is formed which occupies a very much greater volume than the original cement.

It is likely that the same phenomenon occurs in the concrete mixture, on a smaller scale, when immersed in water, resulting in the expansion previously noted. When the water dries out of the concrete, the colloids shrink in volume owing to the loss of water and the concrete mass shrinks. The expansion and contraction of the rock aggregate due to the change in moisture content may also influence the change in length of the concrete mass of which it is a part."

The results of tests and experiments given above explain the causes of many of the faults which develop in concrete work and are useful in that they suggest what conditions must be avoided or met with in good concrete design.

The fact that 1:2:4 concrete specimens hardening in air contracted 0.00068 inch per inch of length explains the cracking of plain concrete walls and similar constructions even when temperature changes are negligible. The shrinkage of concrete sets up tensile stresses in the mass which the tensile strength of the concrete (100 to 200 lbs per sq. in.) cannot resist and cracks are the result. To illustrate, take a retaining wall of a length of 100 ft., the weight of the wall being sufficient so that the middle portion of the wall can be considered rigidly held. The stresses due to shrinkage in hardening, using the figures given above and temperature effects not being considered, will be equal to the modulus of elasticity multiplied by the shrinkage coefficient, or $2,000,000 \times 0.00068$, which equals 1,360 lbs. per square inch. It is readily seen that no plain concrete structure is capable of resisting such stresses, and the decrease in length being about 0.8 of an inch, cracks are sure to result. To produce the same amount of contraction a fall of temperature of 124° F. would be necessary, but since very few concrete structures are subject to anything like the above mentioned difference in temperature it seems that the stresses due to shrinkage while hardening are the ones to be provided for and that temperature changes are of a secondary character.

The shrinkage of neat cement due to hardening in air was found by Prof. White to be 0.109 per cent at 7 days, 0.236 per cent at six months and 0.322 per cent in four years. This would produce a contraction of about four inches in one hundred feet at the end of four years and 2.8 inches at six months which is $3\frac{1}{2}$ times that of 1:2:4 concrete. Prof. White also found that 1:3 mortars contract from 0.08 to 0.1 per cent which is roughly $1\frac{1}{2}$ times the contraction of 1:2:4 concrete due to hardening in air.

This explains the fact that plastered concrete surfaces crack and chip off and also that rich stuccos soon crack and become unsightly. It also explains the presence of hair cracks and checks in the mortar finish of floors, walks and pavements. The difference in the shrinkage coefficients of the mortar facings of walls, walks, floors, etc., and the main concrete mass will in many cases cause the splitting apart of the two and in the case of walks and floors they will soon become unfit for use and have to be renewed.

The experiments made by the Office of Public Roads show that the presence of 0.63 per cent of reinforcement reduces the contraction of concrete hardening in air, to less than one-half that taking place in an unreinforced specimen. This, of course, is to be expected and means that in reinforced concrete retaining walls expansion points or rather contraction

like cracks in numerous places due to the shrinkage of the concrete in hardening in air, when water was put in the tank the concrete started to expand and the cracks being relatively small due to presence of reinforcement, were soon closed up by the expansive action. The action can be likened to the swelling of a wooden pail or barrel when filled with water after having dried out and become leaky.

Although, as stated before, the influence of temperature changes on the expansion and contraction may be considered a secondary one, it is easy to see that in some cases these changes combined with the effects of the hardening of the concrete mass may produce stresses greatly in excess of those produced by hardening alone. The Boonton Dam experiments and others, show conclusively that heat is generated in large masses of concrete due to the chemical action taking place when the concrete hardens. Now when this chemical action ceases and the heat dissipates, additional contraction, due to fall in temperature will result besides that which takes place during the hardening process of concrete cured in air. In mass concrete poured in the late fall we have the combination of contraction due to fall of temperature of the concrete mass, to fall of atmospheric temperature and that contraction which takes place when concrete hardens in air regardless of temperature changes. For example, let us suppose that the drop in temperature of the concrete mass for a period of 6 months due to atmospheric change and the dissipation of the heat generated by the chemical action is 100 degrees F. Then the contraction due to the atmospheric change would amount to 0.00055-inch per inch of length and that due to the drying out of the mass to 0.00068-inch or a total of 0.00123-inch per inch of length. If the concrete structure was 50 feet long, the total contraction would amount to nearly $\frac{3}{4}$ inch and if rigidly held at the ends this contraction would manifest itself in one or more cracks in the concrete.

With the above information at hand it can be said that in most cases it is contraction points and not expansion points that must be provided in long concrete structures in order not to have unsightly, ragged cracks formed. This, however, does not hold good for walls with recesses, sharp bends or angles in same. In this case the expansion due to increase of pressure is sure to rupture the wall at the angle due to the fact that the expansive forces are acting against each other. Numerous cracks at the corners of concrete reservoir walls and at points in concrete retaining walls in track elevation work, where walls have been built at the same time as abutments with which they connect at right angles, are examples of this disruptive force.

Shrinkage cracks are sure to manifest themselves at points where large masses or thick walls join relative smaller or thin walls unless provision is made in design to care for the stresses set up. This can be accomplished in a way by the use of fillets, thereby reducing gradually from the larger dimensions to the smaller. Shrinkage cracks are very likely to occur at points where new concrete is joined to that which has already set and for this reason it is desirable to have construction points made on horizontal or vertical lines if for no other reason than for appearance.

In straight retaining walls contraction joints properly placed will care for all expansion which takes place after hardening, due to moisture or rise in temperature. These joints which only need to be a fraction of an inch in thickness so as to insure free movement between the two portions, should be so spaced that when the wall contracts, the shortening will take place at the joints and not at intermediate points. That is to say, they shall be so placed as not to allow fixed end conditions to arise, due to friction between the wall and fill and to weight of wall, which if present would be sure to cause contraction cracks between contraction joints. This can usually be accomplished with joints every 25 to 40 feet. The joints should be so arranged and constructed as to prevent them from being filled with earth, gravel, etc., which would not allow proper expansion and result in excessive compressive stresses being set up in the concrete.

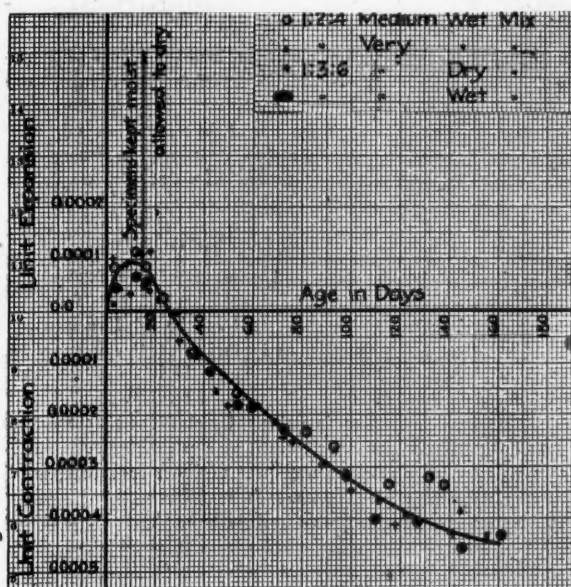


Plate II. Expansion and Contraction of Concrete While Hardening.

points can be farther apart than in plain concrete walls. When contraction takes place in a reinforced concrete structure or part thereof which is not rigidly held at the ends, compression stresses are set up in the steel but when the ends are rigidly held, tensile stresses are set up in the steel which resists the tendency of the concrete to crack, due to contraction. Thus, in all concrete work, stresses of unknown magnitude on account of conditions of exposure, etc., are very likely to be present which are not provided for in design, and either the factor of safety "saves" the structure or if not great enough, failure results.

The specimens hardening in water in every case expanded for about one month and those subjected to alternate wetting and drying, expanded when wet and contracted on drying. These facts are very significant and show the wide range of stress conditions to which concrete structures are subjected under ordinary conditions of weather and exposure.

The expansion of plain concrete specimens hardening in water was about 0.000075 inch per inch of length, which if the ends of the specimen were fixed would produce a compressive stress of 150 lbs. per square inch in the concrete at the end of 3 months and in concrete beams the bars would be subjected to a high initial tension due to this expansion.

It often happens that concrete tanks and reservoirs when first filled with water, leak considerably and after a time this leaking is stopped almost entirely. This is often explained as due to the silting up of the hair cracks and porous spots in the concrete. More often, however, the chances are (where the concrete is of a good quality), that the tank contained hair-

In reinforced concrete walls, contraction joints can be placed farther apart, for if properly reinforced, the steel tends to distribute the contraction stresses and to make the cracks very small, in fact practically invisible, but never entirely eliminating them.

Assuming that reinforced concrete will shrink the same as plain concrete and that the value of 0.0003-inch per inch obtained for a reinforced concrete specimen mentioned in the tests cited above, indicates the net contraction and that there is a high compression in the steel which tends to resist the shrinkage, by using the value of 0.00068 as the unit of shrinkage we can obtain the stresses in steel and concrete.

The net contraction as measured by the concrete will be $C = (fc \div Ec)$ where C = the coefficient of contraction of plain concrete; fc = unit tensile stress in concrete and Ec = the modulus of elasticity of concrete, equal to 2,000,000. The net contraction as measured by the steel will be $fs \div Es$; where fs equals to compressive stress in steel and Es the modulus of elasticity of steel. These two values must needs be equal and for equilibrium $fc = pfs$ where p equals the steel ratio.

The value of fc can be found as follows:

$$fc = CEc \frac{np}{1+np} \text{ and that of } fs = fc \div p.$$

Now if $C = .00068$, $Ec = 2,000,000$, $n = 15$ and $p = 1$ per cent. $fc = 177$ lbs. per sq. in. tension and $fs = 17,700$ lbs. per sq. inch compression. These actual stresses are probably not as large as indicated by the formulae because of a probable adjustment in the concrete hardening with steel in place, which results in less internal stress developing.

The figures nevertheless, indicate that stresses due to shrinkage of concrete are very important and in many cases should be taken into account in designing structures in order to prevent cracks or failures. Then also the repetition of the stresses caused by alternate expansion and contraction may subject concrete to a fatigue which will ultimately cause failure.

ABSTRACTS FROM SPECIAL COMMITTEE REPORT ON CONCRETE AND REINFORCED CONCRETE.

A. S. C. E., 1913.

Precautions.

Failures of reinforced concrete structures are usually due to any one or a combination of the following causes: defective design, poor material, faulty execution and premature removal of forms.

The defects in a design may be many and various. The computations and assumptions on which they are based may be faulty and contrary to the established principles of statics and mechanics; the unit stresses used may be excessive, or the details of the design defective.

Articulated concrete structures designed in imitation of steel trusses may be mentioned as illustrating a questionable use of reinforced concrete, and such structures are not recommended.

Poor material is sometimes used for the concrete, as well as for the reinforcement. The use of poor aggregates (especially sand) which have not been tested, is a common source of defect. Inferior concrete is frequently due also to lack of experience on the part of the contractor and his superintendents, or the absence of proper supervision. An unsuitable quality of metal for reinforcement is sometimes prescribed in specifications for the purpose of reducing the cost. For steel structures a high grade of material is specified but the steel used for reinforced concrete is sometimes made of unsuitable, brittle material.

Faulty execution, careless workmanship and too early removal of forms may generally be attributed to unintelligent and insufficient supervision.

Responsibility and Supervision.

The design of reinforced concrete structures should receive at least the same careful consideration as those of steel, and

only engineers with sufficient experience and good judgment should be entrusted with such work.

The computations should include all minor details, which are sometimes of the utmost importance. The design should show clearly the size and position of the reinforcement and should provide for proper connections between the component parts, so that they cannot be displaced. As the connections between reinforced concrete members are frequently a source of weakness, the design should include a detailed study of such connections, accompanied by computations to prove their strength.

The execution of the work should not be separated from the design, as intelligent supervision and successful execution can be expected only when both functions are combined. The engineer who prepares the design and specifications, therefore, should have supervision of the execution of the work.

Before work is commenced, complete plans shall be prepared, accompanied by specifications, stress computations and descriptions showing the general arrangement and all details. The plans shall show the size, length, dimensions for points of bending, and exact position of reinforcement; including stirrups, ties, hooping, and splicing. The computations shall give the loads assumed separately such as dead and live loads, wind, and impact, if any, and the resulting stresses. Inspection during construction shall be made by competent inspectors employed by and under the supervision of the engineer and shall cover the following:

1. The materials.
2. The correct construction and erection of the forms and supports.
3. The sizes, shapes and arrangement of the reinforcement.
4. The proportioning, mixing and placing of the concrete.
5. The strength of the concrete, by tests of standard test pieces made on the work.
6. Whether the concrete is sufficiently hardened before the forms and supports are removed.
7. Prevention of injury to any part of the structure by and after the removal of the forms.
8. Comparison of dimensions of all parts of the finished structure with the plans.

Don't laugh at those who make mistakes,
And stumble on the way,
For you are apt to follow them—
And almost any day.
Don't think the others shifting sand,
While you are solid rock,
And don't forget, for heaven's sake,
That any fool can knock.

The Santa Rosa, Palma & Albuquerque has been organized in New Mexico to build from Santa Rosa, N. Mex., west to Albuquerque, about 125 miles. To provide for making the necessary surveys and other preliminary work \$25,000 has been subscribed by residents of Santa Rosa, N. Mex.

The Continental Building & Construction Co., St. Louis, Mo., according to reports has been awarded the contract for the construction of the new Wabash passenger station at Fort Wayne, Ind. Work will be started at once.

The Great Northern block system in Washington will soon be completed from Scenic to Tye, from Everett to Skykomish and from Everett to Bellingham, bringing the entire main line from Leavenworth to Seattle and the coast line as far north as Bellingham under the block system.

The Missouri Pacific is in the market for 1,000 40-ton stock cars.

The Seaboard Air Line has ordered 500 box cars from the Pressed Steel Car Co., 250 flat cars from the American Car & Foundry Co. and 250 hopper cars from the Standard Steel Car Co.

The Southern is said to be in the market for 1,800 freight cars.

The Wabash is in the market for 1,000 box cars.

The Engineer's Distress

MAY-1913

A.S. Gunn Editor

THE HOBO ENGINEER

Sometimes I think I'll quit this life
 And settle down and get a wife.
 Sometimes I think that I would like
 To have a place that I call home,
 And settle down no more to roam.
 But hell, that very thing I've tried
 And find myself dissatisfied.
 I've often tried to settle down
 To office work, and live in town.
 And act as civilized folks do
 Take in the shows and dances too,
 But I no more than got a start, when
 Wanderlust would seize my heart.
 And in my night dreams I can see
 The great white silence, calling me.
 Then at the chance near I would fail
 To drop it all and hit the trail.
 Back to the solitudes again
 With transit level, rod and chain
 And do the same things or and or
 Day after day, week after week.
 Sometimes we would go to town
 To seek a little fun, and, sometimes
 Well, to raise a little hell.
 Now we don't mean to, but you see
 When we've been out two months or three
 In silent places, where the night face
 Of a white man's out of place,
 We hit again the great white way
 Our joyful spirits get full away.
 And when we crowd into one night
 The joys of many months, its right
 Well maybe not, but it's not for me
 To shape our final destiny.
 When our last survey is done
 And tied up to the great unknown,
 And to our child our records brought
 Of dangerous work and hardships fought
 Of lonely work we have endured
 That the best result might be secured;
 Against all this, our little sprees
 Will seem as brooks compared to seas
 And angels surely will decide.
 There's a balance on the credit side.
 Then God I think will drop a tear
 And bless the

HOBO ENGINEER.



The Signal Department

AUTOMATIC BLOCK SIGNALS, C. M. & ST. P. RY. PUGET SOUND LINES.

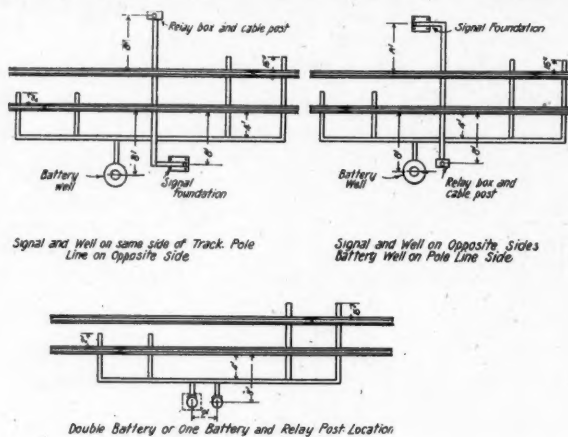
B. W. Meisel.

During the season of 1912, automatic block signals were installed on 119.1 miles of the Chicago, Milwaukee & St. Paul Ry., Puget Sound Lines. Following are the sections of road protected: Lombard to Three Forks, Mont., 19.2 miles, (22 signals); St. Regis to Haugen, Mont., 19.3 miles, (21 signals); Avery to St. Maries, Idaho, 49.3 miles, (55 signals); Kittitas to Cle Elum, Wash., 31.3 miles, (32 signals); making a total of 119.1 miles and 130 signals.

The construction work was done under contract by the Union Switch and Signal Co. Union style "B" three position upward indication signals were used.

The typical signalling schemes 1 and 2 shown herewith, illustrate the method used for signalling a 5-mile, and a 4-mile or less section of road. Each scheme shows a train "A" at station "C" and a train "B" between stations "C" and "D." Train "B" in scheme No. 1 is protected by signal 6 with signal 4 at caution; and will remain so protected until it passes signal 10, at which time signal 6 and 8 will assume the caution position, and 4 will assume the clear; signal 8 having previously been put to "stop." If train "A" leaves station "C" it will be protected by signal 4 up to the point where train "B" is shown, and signal 2 will indicate caution whenever train "A" passes signal 5.

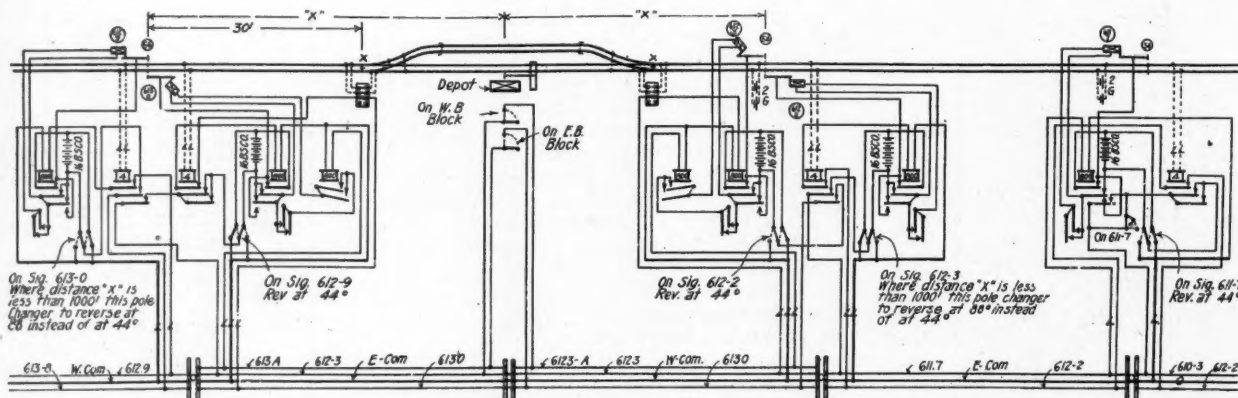
For head-on moves, assume train "B" at station "D." With this condition, signals 2, 3, 10, and 11 would indicate "stop," with signals 5 and 8 at the caution position, and the remaining signals clear. It is evident that if one or the other of the trains advanced, it would proceed under clear signals up to signals 5 or 8, at caution, then to signals 3 or 10, at "stop." If, on the other hand, the trains "A"



Typical Location Layouts.

and that for inbound signals at stations, the 45 to 90 deg. control breaks through a neutral line relay controlled by the train order signal at the station. That is, when the station board is not clear, the in-bound signals indicate caution. If "X" the distance from the in-bound signals to the depot is less than 1000 ft., then the pole changers operated by the in-bound signals are made to operate at 88 instead of 44 deg. When this condition occurs, the first signal in the rear of the in-bound signals will indicate "caution," when the station board indicates "stop."

Lightning arresters are used only where relay coils are connected to the line or track; line circuits break through facing point switches, and common breaks at the in-bound



Typical Circuit for Signal Scheme No. 1.

and "B" were allowed to leave the stations with a clear board, it would be possible for train "A" to pass signal 4 at clear, and for train "B" to pass signal 10 at clear. In that case both trains would reach stop signals at 6 and 7 without a caution indication, allowing only a 2000 foot braking distance for each train. This would seem a dangerous condition if it were not for the fact that the possibility of both trains passing clear station boards would be quite remote.

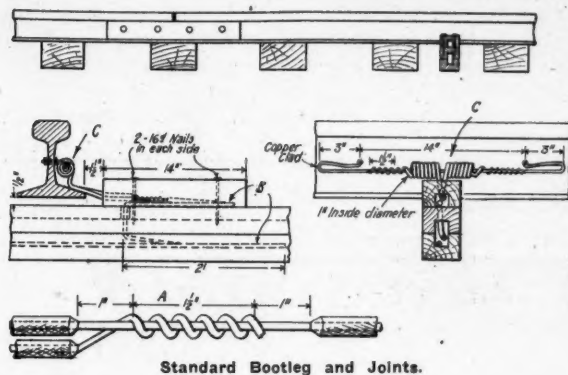
Scheme No. 2 is much the same as No. 1 except that signals No. 5 and No. 8 are eliminated.

The circuit plan shown herewith is typical for scheme No. 1. Note that polarized line relays are used for the control of the 0 to 45 deg. and 45 to 90 deg. position of the signals,

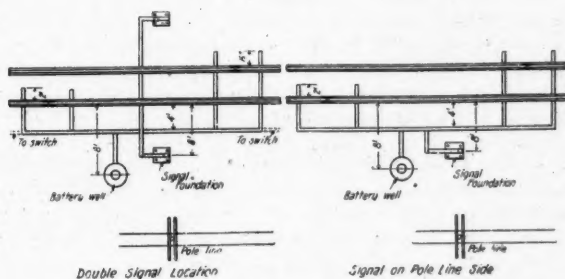
signals. Line circuits and signals receive current from the same set of battery, composed of 16 B. S. Co. cells.

The detail plan of pole line construction, shown herewith, gives the location of the wires on the cross arm pins, with common on the field side. Lightning arresters are located in the box on the pole. Taps from the line enter the side of the box, and the cable which is made up as required, from No. 14 B. & S. Okonite rubber insulated wire, is tied to No. 9 galvanized iron messenger wire, with marlin, every 18 inches. The cable enters the signal case at the top through a goose neck, as indicated. The lower set of cross-arms are used for signal wires.

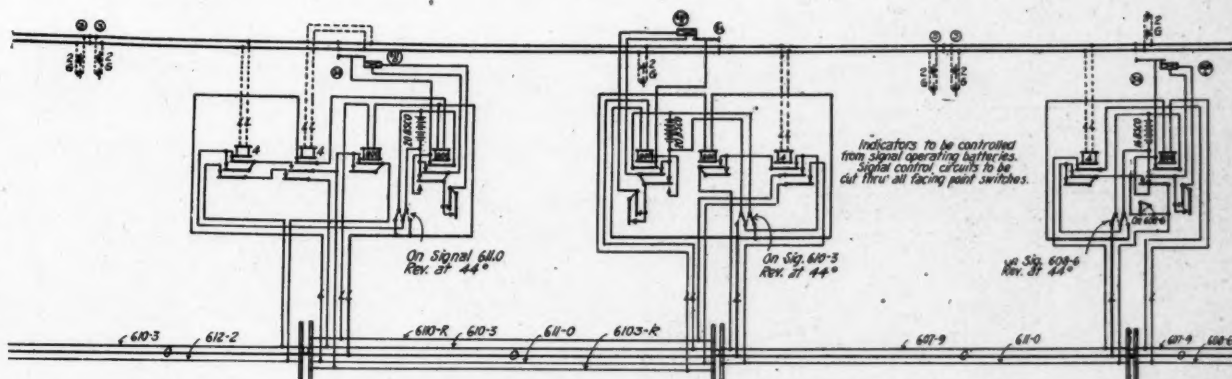
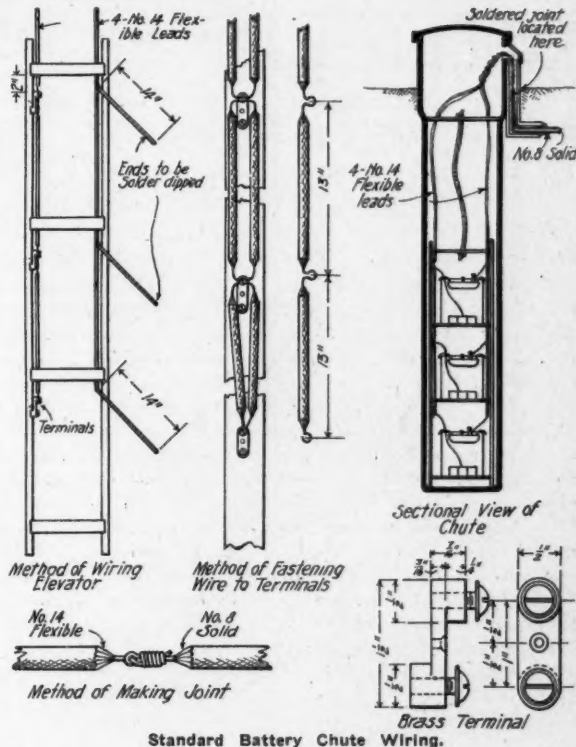
The standard boot leg and track circuit connection is made according to plan, shown herewith, from 3 pieces of



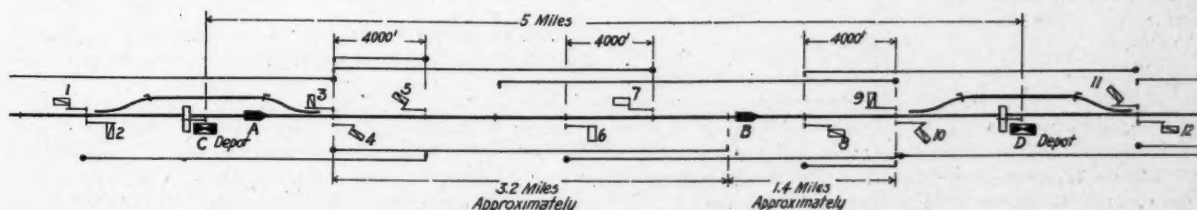
Standard Bootleg and Joints.



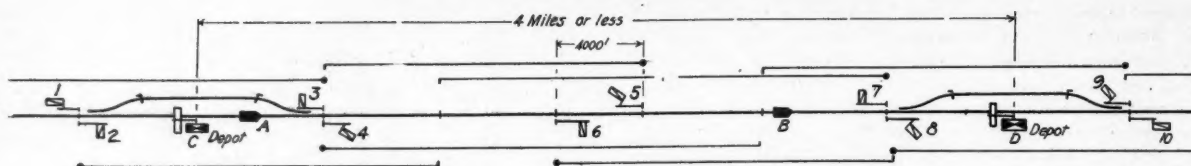
Typical Location Layouts.



Typical Circuit for Signal Scheme No. 1.—Continued



Typical Signaling Scheme No. 1.



Typical Signaling Scheme No. 2.

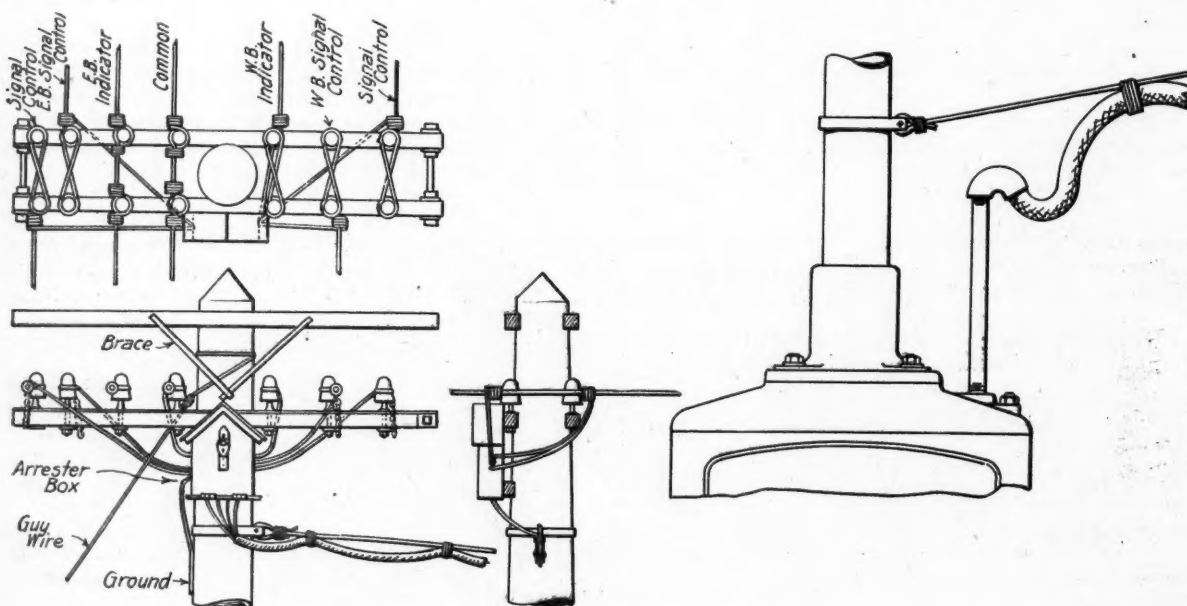
grooved trunking placed and fastened together. The top piece which serves as an outlet for the track connection is cut 14 in. long, and is fastened to the lower two sections by two 16d. nails on each side of the groove, at a distance of $1\frac{1}{2}$ in. from the rail; the lower two sections are $\frac{1}{2}$ in. from the base of the rail. The track connection is made by joining a 2-ft. piece of No. 8 B. & S. rubber covered wire to the main run of wire, at a point 2 ft. more or less, from the end in the manner shown at A. The joint is well soldered using a resin flux, and then painted well with two coats of P. and B. compound. Enough wire is left in main run to allow a 14-in. loop in the groove of the top piece of trunking, and a 2-ft. loop in the two lower sections, as shown at B. The free ends are then wound in the form of a spiral around a copper clad bond wire, the spiral to have 1 in. inside diameter, the ends of which are to be soldered to the bond wire. The completed joint is shown at "C."

The standard method of wiring a battery chute elevator

Personals

Burt T. Anderson has been appointed assistant signal engineer of the Atchison, Topeka & Santa Fe Ry., succeeding J. E. Saunders, resigned to become assistant signal engineer of the Delaware, Lackawanna & Western Ry. Mr. Anderson is a graduate of the electrical engineering department of the University of Illinois, class of 1907. Since that time he has served a three year apprenticeship with the Union Switch & Signal Co. and has held the positions of draftsman, construction foreman, junior assistant signal engineer, and chief draftsman A. T. & S. F. Ry. up to the time of his present appointment. He is a member of Committee III of the Railway Signal Association.

E. H. Clark has been appointed signal foreman of the Atchi-



Details of Pole Line Construction.

has some interesting features. The connections between the copper electrodes and the track feed wires are made by using a cast brass terminal, a detail of which is also shown. This brass terminal is fastened to the vertical strips of the elevator just below the battery shelves. The leads are No. 14 flexible.

The figures showing the standard method of locating apparatus on single track are self explanatory.

The construction work was done under contract by the Union Switch and Signal Co.

We are indebted to Mr. L. W. Smith, signal engineer of the Chicago, Milwaukee & Puget Sound Ry., for the data and illustrations from which this description was prepared.

son, Topeka & Santa Fe Ry. at Arkansas City, Kan., effective March 10, succeeding A. Brown, transferred to Emporia, Kan. Mr. Brown succeeds G. K. Thomas. G. W. Johnson has been appointed construction signal foreman at Chanute, Kan.

L. R. Byram has been appointed assistant signal engineer of the Buffalo, Rochester & Pittsburgh Ry., office at East Salamanca, N. Y.

T. A. Foss has been appointed signal supervisor of the Chicago & Alton Ry. at Bloomington, Ill., succeeding P. G. Peters, effective April 1.

J. E. Saunders, who has been appointed assistant signal engineer of the Delaware, Lackawanna & Western R. R.,

entered railway service in the engineering department of the Atchison, Topeka & Santa Fe Ry. in 1903. Later in the year he entered the Armour Institute of Technology, electrical engineering course. During four years he attended school, and was employed during vacations in the signal department of the Santa Fe, as helper, batteryman, clerk to division foreman, and also on construction work. In 1907 he entered the service of the Illinois Central R. R. as draftsman, but in the same year re-entered the service of the Santa Fe as chief draftsman, signal department, at Los Angeles, Cal. He was later division foreman, and during the last three years was assistant signal engineer at Topeka. He resigned March 15 to accept the position of assistant signal engineer of the Delaware, Lackawanna & Western R. R. at Hoboken, N. J. He received the degree of electrical engineer from the Armour Institute of Technology in 1911.

W. B. Weatherbee has been appointed general electric signal inspector of the Delaware, Lackawanna & Western R. R., office at Newark, N. J. A. J. Anderson has been appointed signal supervisor at Binghamton, N. Y., succeeding C. S. Gaunt. H. A. Applegate has been appointed signal supervisor at Scranton, Pa., effective April 1.

N. E. Baker has been appointed supervisor of signals of the Grand Trunk Ry. at Battle Creek, Mich. R. W. Bensett has been appointed supervisor of signals at Durand, Mich.

L. D. Woods has been appointed signal supervisor of the Missouri Pacific Ry. at Little Rock, Ark., succeeding M. Weld.

O. P. Aanonsen has been appointed engineer, signal department, of the New York Central & Hudson River R. R. at Albany, N. Y. T. Kittridge has been appointed signal inspector at Albany, N. Y. W. H. Newman has been appointed signal supervisor at Buffalo, N. Y., effective April 15. F. Rapp, assistant signal supervisor, has been transferred from Poughkeepsie to Albany, N. Y., effective April 14.

R. E. Taylor, who has been appointed assistant engineer, signal department, New York, New Haven & Hartford R. R., as was announced in *Railway Engineering*, was born in Springvale, Maine, March 7, 1884, and attended the public schools of



J. E. SAUNDERS, Assistant Signal Engineer.
Delaware, Lackawanna & Western Ry.

Springvale and graduated from the University of Maine at Orono, Maine, in June, 1905. In August, 1905, he entered the test department of the General Electric Co. at Schenectady, and in December, 1906, accepted a position with the New York, New Haven & Hartford R. R. as inspector on construction of the 11,000-volt catenary system between New York and Stamford, with headquarters at Cos Cob. In November, 1907, he entered the signal department drafting room at New Haven, Conn., as draftsman, and in December, 1910, was promoted to the position of signal inspector with headquarters at New Haven. September 1, 1912, he was promoted to the position of assistant engineer in charge of office engineering and the drafting room.

The Maintenance of Way Department

PROTECTING AGAINST AND REPAIRING WASHOUTS.

By J. W. Powers, Supervisor of Track.

One of the most common, costly and dangerous problems that a railway company has to contend with is the labor, material and protection required in preventing and repairing washouts.

While washouts may occur during any season of the year, the most severe damage is done early in the spring. This is caused by the melting snow together with heavy rains which greatly increase the volume of water. As the frost is still in the ground, or coming out slowly, ditches, culverts and other water channels are taxed to their utmost capacity.

It is at this time of the year, particularly, that the old adage, "An ounce of prevention is worth a pound of cure," is brought forcibly to the minds of the maintenance of way forces. They should always be on the alert to increase the strength and permanence of the roadbed and structures upon which the track rests. Anything detrimental to same should be carefully observed and corrective measures applied.

To guard against washouts, there should be a thorough system of ditches, drains, culverts, bridges and other channels of sufficient size and number to carry water during the heaviest freshets and conduct it to a point beyond the possibility of its injuring the track. A surface ditch is especially indispensable in deep cuts as during a heavy rain the water falling upon the side slopes and track is about all that ordinary side ditches can accommodate. If the protection afforded by surface ditches is lacking, large quantities of surface water are discharged upon the unprotected slopes, carry-

ing quantities of earth which are liable to block the side ditches and produce a washout of more or less magnitude.

In deep, wet cuts where the land has a tendency to slide, the roadbed should be made much wider than at other points. The side slopes should be made with a gradual incline, at least $1\frac{1}{2}$ feet horizontally to one foot vertically and more if necessary, to promote the growth of vegetation. Vegetation helps to prevent the soil from sliding and filling up ditches.

Much trouble is often experienced in protecting railroad embankments from being cut or washed away by streams or creeks which run parallel with the roadbed. The safest and sometimes cheapest method of protecting the roadbed, is by changing the channel of the stream at these points, thereby avoiding the necessity of protecting the bank by artificial means. However, if this cannot be accomplished, and the water is swift and deep, a good concrete wall will afford the most reliable protection. Rip-rap weighing from fifteen pounds to fifteen ton may also be used. Rip-rap affords ample protection if the large stones are placed next to the current and the foundation is carried below any earth which is liable to be moved by the action of the water. The small stones may be used to fill the cavities between the larger stones.

Fig. 2 shows rip-rap being placed to protect an embankment carrying freight tracks along the shore of Lake Ontario.

Another method of protection in the same vicinity is in the form of a crib, shown in Fig. 1. While the method shown in Fig. 1 gives excellent satisfaction, the method shown in Fig. 2 is to be preferred as it is almost indistructible if properly placed.

One of the diagrams shows paving applied for protection to

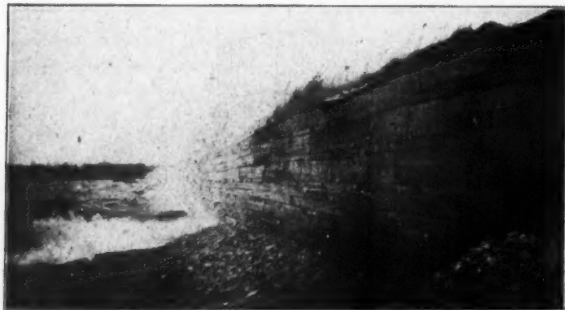


Fig. 1.

embankment, along Onondaga Lake, which is exposed to the destructive action of the waves. The paving, shown in the sketch, is still ample protection against the water, although it was constructed several years ago. It was found inefficient against floating ice which moved with considerable force, especially during high water and severe wind storms. At such times it was necessary to use a snow plow to remove the ice which was forced upon the track. This has not occurred recently, as the track has been raised and the embankments properly protected. To accomplish this it was necessary to place large rip-rap outside the paving to prevent it from being moved out of place or undermined. Rip-rap is placed by steam cranes, two used when obtainable to expedite the work and reduce the cost of handling the stone. The cranes were manipulated by the same engine and crew. Fig. 3 shows method of unloading this rip-rap.

The supervisor should be ever vigilant in the inspection of his sub-division, going over it either by walking, velocipede, hand or motor car at short intervals. The condition of bridges, culverts, trestles, retaining walls, sea-walls, and tunnels, should be carefully noted. Immediate action should be taken to remedy any defects endangering safety. The supervisor should report to his superiors any structures that he considers unsafe or in urgent need of attention.

In addition there should be a well organized system of track inspection. Under ordinary conditions track inspection can be entrusted to a competent and reliable track walker. This man should make a careful examination of that portion of track allotted to him each day, and see that everything is in safe condition; especially anything affecting safe traffic. He should thoroughly understand how to display signals and should always carry them when on duty.



Fig. 2. Placing Heavy Rip-Rap.

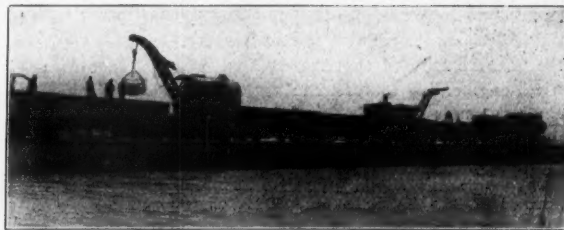


Fig. 3. Unloading with Two Cranes, Using Only One Engine and Crew.

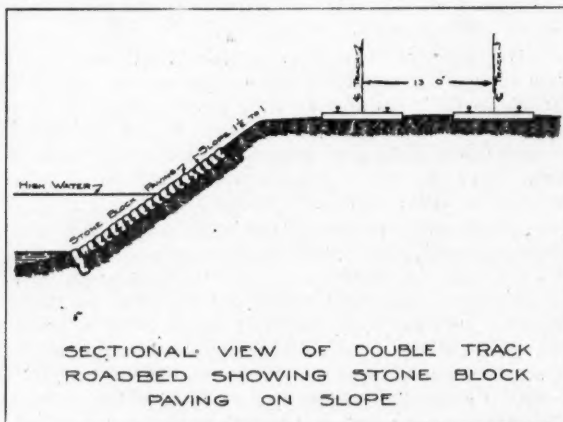
The section foreman should go over and examine his entire section at least twice a week, and oftener if necessary. During wind and rain storms he should be out with a sufficient force of men, supplied with proper signals, tools and instructions, to insure the safety of trains. Every precaution to prevent accidents should be used. To accomplish the desired results, during bad storms the foreman should be compelled to go over his entire section at least once a day and oftener if necessary.

All drains, ditches, culverts, bridges and other water channels should be kept free from debris, ice and snow. The importance of doing this cannot be too forcibly impressed upon the foreman, as its accumulation in common water channels causes many washouts; and material such as ties, lumber or fence posts should not be unloaded or piled where they are liable to be carried away by high water.

When there is a possibility of any trouble, the section foreman should remain out with his men day and night, increasing his force if necessary. He should note the location and dimensions of any places needing repairs, reporting jointly to the superintendent, division engineer and supervisor, stating the condition of any portion of his track not safe for schedule speed, and the location and extent of any damage done to track, bridges, culverts and, in fact, any information should be given that would be of value to the supervisor to enable him to procure the kind and amount of material to put track in good condition.

On receipt of such information the supervisor should at once proceed to the point of danger and take full charge of the work. Temporary repairs should be made if permanent ones cannot be on account of high water, lack of material, or other causes. The policy should be not what "ought to be done," but what "can be done" with the material at hand.

To illustrate this I have in mind an instance of where water was rapidly rising above the high water mark. To properly protect the embankment it was necessary to have rip-rap. A construction train was immediately dispatched to load same from stone walls used to fence our right of way. But before rip-rap could reach the point to be protected the water began to undermine and wash away the embankment. Prompt action was necessary to keep track in service. One thousand cement bags were procured, filled



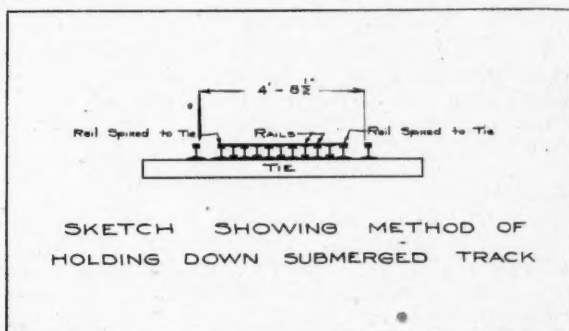
with sand, and together with five or six hundred ties and lumber, prevented further damage and enabled traffic to continue. Upon the arrival of train the undamaged bags were removed and rip-rap substituted.

On another occasion, when a large number of logs formed a jam, the water rose 10 feet in a few hours, changing the course of the river, causing the water to undermine and threaten to wash away a large sand embankment. By using a pile of lumber belonging to an independent party, the fill was protected until the jam was broken by dynamite. The damage to the lumber was between \$40 and \$50, but its use saved a large embankment and delay to traffic.

When track is submerged, great caution should be exercised to hold same intact. A common method is to place loaded cars on it. Another method that may be used to advantage is shown by the diagram.

There are no set rules that can be adhered to in repairing washouts, as the plan of procedure depends upon the magnitude and condition of same, together with the ability and knowledge possessed by the person in charge and also the material available.

A supply of long stringer piles and other emergency material



should always be on hand, located where it can be loaded quickly and rushed to the point of danger. If only the top of embankment is washed away for a depth of two or three feet, the track can be made safe for slow speed by cribbing and blocking with ties, planks, or boards. Flat stones may be used to block or shim up with so that all ties will have a solid bearing, after which ballast can be dumped, blocking removed, and track put in good condition. If a washout is caused by water running parallel with track and only one side is undermined or washed out, it might be possible to throw or line the track to one side so that a bearing may be secured for the entire tie. This is a quick and cheap method. Material can then be unloaded to fill up the washout, and the track lined to its original position.

Another method is to level down the remaining portion of embankment, leaving a sag in the track. If ballast is at hand it is not necessary to take much pains with the grading as the ballast can be dumped, commencing at the end of the washed embankment. The cars can be pushed ahead of the engine, using ties or timber to the level of the ballast. This makes the track fairly solid for temporary use, but track should be raised and tamped as soon as sufficient material is unloaded to give a good lift. This operation can be repeated until the work is complete.

A combination of the above methods may be used to advantage in some cases; that is, in lowering the track and lining it over to secure a solid bearing. Care should be taken not to make a change of grade so abrupt as to uncouple cars.

Another method is to support the overhanging or undermined side by driving piles on which caps are placed, supported on the other side by the bank. Stringers are placed on the caps. Sometimes posts are set on mud sills, used instead of piles, but the latter are preferable as they afford more protection against the sliding of the embankment. By making repairs in this manner the grade and line is preserved.

If the entire embankment is washed away and there is no deep

water to contend with, a washout can be repaired very rapidly by cribbing with ties or timbers. The cribbing should be kept level and sawed ties are preferable for this work. If the current is swift, the cribs can be sunk by loading them with stone or scrap iron. If the cribbing interferes too much with the flow of water, an opening sufficient to carry the water can be made by placing stringers on the cribs, thus forming a bridge. When it is necessary to build high cribs, long ties such as switch or bridge ties should be used, especially at the bottom. If such ties cannot be secured, a good structure can be made by building two cribs together.

If the water is deep and the washout a large one, two pile drivers should be put in service. If only one can be secured or there is a scarcity of piles, it may be possible that the depth of water is such that crib can be used on one end and piling driven on the other. There are other methods of repairing washouts but I will not enumerate further.

It is of the utmost importance that the superintendent and dispatchers be kept informed of the progress made in the repairing of damaged track. Such information enables them to make arrangements for the moving or detouring of trains.

Owing to the vast improvements made in roadbed structures and rolling stock, together with the adoption, enforcement of and faithful compliance with the rules now existing on all first-class roads, accidents have been reduced to a minimum. But despite all precautions there is nothing that can give absolute surety against them. This has been brought forcibly to mind in the mountainous regions where cloud bursts and heavy rains fill up canyons and gorges with large volumes of water which rush with such force and fury that every obstacle in the path is swept away, destroying roadbeds, tracks, bridges and other structures designed by the best engineering talent.

SERVICE TESTS OF TIES, PROGRESS REPORT.

The United States Forest Service, in co-operation with various railways and treating plants, has installed a number of experimental tie sections to test durability of ties under various conditions. There are eight of these sections now established, a report of which appears in a recent Bulletin of the United States Forest Service. The general practice has been for the railways to treat the ties and place them in the track. In the C. M. & St. P. Ry. test section, however, they were treated at the Forest Products Laboratory. The rest of the treated ties in the experimental sections were treated by commercial companies. The following classifications are used in the inspections: Decayed—ties which must be removed soon; partially decayed—ties partially decayed but still serviceable; split—ties noticeably split but still serviceable; spike cut—ties having loose spikes, or badly damaged; worn—ties damaged by rail or plate, but still serviceable; good—ties not appreciably affected with decay, not badly checked, worn or split.

Gulf, Colorado & Santa Fe Test Track.

This test section containing 5,477 ties was installed in 1902 on a level tangent between Pelican and Cleveland, Tex. Drive spikes were used, without tie plates. The ballast is sand, the drainage poor. The rail is 60 and 61-lb.

The object of the test was to determine: (1) The durability of untreated beech; hemlock; black, red, Spanish, turkey, white and yellow oak; loblolly, longleaf and shortleaf pine, and tamarack. (2) Relative value of the Allardye, Burnett, Hassellmann and Wellhouse process; also relative values of Beaumont oil, with spirritine; zinc chloride combined with Beaumont oil; and English creosote. The absorption records are of doubtful value because the relative number of ties treated at any one plant was small and various species were treated in the same charge.

The following deductions are made from the result of an inspection of this track in 1909. (1) Zinc chloride is an effective preservative for ties subjected to severe wear; after 7½ years

87 per cent of the ties treated by the Burnett process, 4 per cent solution, were still serviceable, and 92 per cent of those treated by the Wellhouse process were still serviceable. (2) A fairly heavy unpregnation of zinc chloride is advisable. A treatment of only 2 per cent solution showed 45 (Burnett) and 47 per cent (Wellhouse) of serviceable ties after 7½ years. (3) A light injection of creosote adds to the effectiveness of zinc chloride treatment. Under the Allardye process the use of creosote with zinc chloride showed 81 per cent still serviceable, and with zinc chloride alone, treatments at same plant, only 45 per cent were serviceable. (4) Ties must be sound when treated. (5) Ties should be separated into species when treated. (6) Species, which when untreated, decay most rapidly, appear to give the greatest relative increase in service when treated. Treated loblolly, pine, hemlock, beech and tamarack appear when treated to be about as durable as untreated long-leaf pine, Spanish oak, and white oak.

Northern Pacific Ry. Test Track at Plains, Mont.

The Northern Pacific Ry. has a test track containing 2,650 hewed ties, 7 ins. by 9 ins. by 8 ft., just west of Plains, Mont. The ties were installed in 1907 on a tangent in gravel ballast, the track drainage being good. Several forms of tie plates, and screw and cut spikes were used.

The object of the test is to secure information on (1) durability of green and air seasoned Douglas fir, and western larch; (2) durability of Burnettized Douglas fir and tamarack; (3) efficiency of flanged, flat and wooden tie plates, when used with both cut and screw spikes.

The Burnettized ties had an injection of about 0.786 pounds of dry zinc chloride per cubic foot.

Results to date show: (1) Ties do not show a marked difference in durability; (2) western larch ties have checked more than Douglas fir; (3) zinc-treated ties are rail worn more than untreated ties; (4) untreated larch ties are more rail worn than untreated Douglas fir, but less than either kind of treated ties; (5) flat metal plates are causing least damage to ties; (6) wooden plates are unserviceable, work out from under rail, and split badly. They had to be removed in 1910; (7) screw spikes became bent laterally.

Northern Pacific Railway Test Track at Maywood, Wash.

The test track at Maywood has 2,280 sawed ties, 7 by 9 in. by 8 ft., placed in 1906-7. The track includes one 2 deg. and one 5 deg. curve. The ballast is gravel on an earth embankment, with good drainage. Screw spikes as well as cut spikes are used.

The objects were to determine: (1) Durability of green and air seasoned Douglas fir and western hemlock; (2) durability of creosoted Douglas fir; (3) efficiency of flat plates, and relative efficiency of screw and cut spikes.

The treated ties were impregnated with creosote by the full cell process, absorption being 8.6 pounds per cubic foot, of which 2.4 pounds evaporated in seasoning.

The results to date are: (1) Green, untreated hemlock ties are deteriorating rapidly; (2) Douglas fir seems in better condition with respect to checking, rail wear, brooming and decay; (3) The creosoted Douglas fir ties are decidedly more rail cut than the untreated ties.

Chicago & Northwestern Railway Test Track.

The C. & N. W. Ry. has a test section near Janesville, Wis., containing 3,040 hewed ties 6 by 8 in. by 8 ft. They were laid in 1907 on a level tangent, in well drained gravel ballast.

The test was designed to show: (1) Natural durability of eastern hemlock, and tamarack; (2) comparative efficiency of the Burnett, Wellhouse and open tank creosote processes; (3) comparative efficiency of flat and flanged plates, wooden plates, cut and screw spikes.

The zinc chloride ties were treated at the company's Escanaba plant by the Burnett and Wellhouse processes. An injection of 12 pounds of a 4 per cent solution was given. Some

ties were given an open tank treatment with creosote and coal tar, the absorption being about 15 pounds per tie.

In 1911 the following results were noted: (1) About 15 per cent of the untreated hemlock and 13 per cent of the untreated tamarack were removed on account of decay; (2) in addition less serious decay was noted in 8 per cent of the hemlock and 30 per cent of the tamarack ties; (3) only 2 treated ties show signs of decay; (4) 40 per cent of the hemlock and 60 per cent of the tamarack ties, untreated, unprotected by plates were rail cut from one-fourth to one-half inch; (5) no difference was noted in the effect of cut and screw spikes; (6) flanged plates were not all embedded and gravel had worked in under them; (7) wooden plates seemed to damage ties the least; but many were badly split and many were missing; (8) screw spikes were bent outward, on account of having no support under the head; this was especially noticeable with the wooden plates.

Other installations of test tracks were described which have been installed by the following companies: Indianapolis, Columbus & Southern Traction Co., Tennessee Coal, Iron & Railroad Co., Wenatchee Valley & Northern Railway, Chicago, Milwaukee & St. Paul Railway. These installations have not been in long enough to give decisive data.

Summary.

Few of the test tracks have been installed long enough to give decisive results, but the indications are that test tracks, properly conducted, prove valuable in showing relative economies. All treatments, with one exception, have given increased life.

Untreated ties which decay quickly should not be tie plated, as they will decay before wearing out. Treated ties, particularly soft ties, should be protected from mechanical wear.

Wooden plates have not proven satisfactory; flanged plates split the ties and let in moisture; flat metal plates or those with slightly corrugated bottoms have thus far given the best service.

No definite conclusions can be given as to the relative efficiency of screw and cut spikes. Screw spikes should be supported under the head to prevent lateral bending.

RAIL RAVELINGS.

Dear Son:

Have not heard from you for some time and have been wondering if you are mixed up in any washouts during the time of high water, as nearly all roads are having trouble. I believe I have never written you on the subject of "washouts." My experience taught me many things, but the one paramount was this: "Do something." On a main line such as the one on which you are employed do not hesitate to incur necessary expenses either in saving an embankment or bridge, or in restoring them. Your officials, if they are strictly up to date, which no doubt is the case, want men who will go ahead and do things. And the man who is afraid to make a move to save company property in case of emergency, because of the expense, is not the kind of man the up-to-date railway officials of today are looking for.

A case of being afraid to spend a few dollars to save hundreds, perhaps thousands, came under my observation once. A small but important terminal line was threatened with disaster by the washing away of a twenty-five foot embankment, and called for help from the system on which I was employed at this time. We were prepared for an emergency, as our own lines were in trouble on account of heavy rains. We took two trains of mixed dirt and gravel and a carload of bags of sand, and 1,000 empty bags to fill and use if necessary.

When we attempted to use the sand bags the general manager of the line, who, by the way, did not hold his position because he was a practical railway man, stopped us and asked what the cost would be. One of our officials who was there (and it was in the night) was so disgusted at the man's smallness that he left. This man wanted to save the filling, which

we had brought, so badly that he would not allow us to unload enough in any one place to do any practical good. Consequently what work we were allowed to do was of little value in saving the embankment. If we had used the sand bags and then the filling properly we no doubt could have saved a washout.

Do not understand me to mean that you should give no thought to expense in cases of this kind, but neither should you hesitate to spend money in order to save or attempt to save the property of the company.

When rip-rap is available, you may be able in many cases to prevent a washout by simply unloading and piling it in such a manner as to protect the threatened place, or divert the current. I saw a small crew of men save a dike by using ties (neither rip-rap nor sandbags being available), against which they piled dirt and kept the water from overflowing the bank. Had the water overflowed it would have cut a channel in short order, and thousands of acres of rich farm lands would have been flooded; and the railway would have had to pay the damage.

If you have pile bridges where drift is likely to accumulate, watch closely as soon as the water is high enough for drift to begin to run, and try at all hazards to keep the channel clear. In cases of this kind you should have two or three one-inch lines, a hundred feet or more in length, to use for pulling logs and drift toward the shore where you can either land it or turn it in such a manner that it will float through the opening. A set of small blocks should also be kept for the same purpose; also pike poles, chopping axes, and one man cross cut saws for cutting logs that are too long and heavy to drag out. And be sure and have some light, hard lines to use in case a man falls in the water, and to lower men from the bridge to make hitches or cut away debris. In many cases a derrick such as is used in bridge work can be used successfully in removing logs and even trees when the current is swift.

If you are unable to keep the channel clear and drift accumulates watch for indications of an undertow which will scour out the bed of the stream and weaken or wash out the piling. If you see the water boiling up violently below the bridge, you will know there is an undertow. In this case watch the end piles on the up stream side, and if they begin to settle away from the cap ever so little you will know the water is scouring out the bed of the stream and the bridge is unsafe for traffic.

I have said nothing in the letter regarding the restoring of the roadbed or bridges after a washout. You might write an interesting letter on that by giving your experience when you landed on a job in the midst of a five mile washout on a new line.

DAD.

PROTECTING EMBANKMENTS BY PLANTING WILLOWS.

J. A. Walker, Roadmaster.

When an embankment has started washing out, about the only way we can save it is to rush in rock and rip-rap the bank. The rock will help to compact the earth and prevent scour.

Wherever we have fills along a river we protect them with willows. We plant these along the base of the fill, and as they grow up we bend the tops over and cover them with dirt. The tops will soon take root, and after a short time the operation is repeated. Finally the side of the embankment becomes a solid mass of roots, and there is very little chance of water ever washing the dirt away from behind and around these roots. It only takes a few years to get an embankment well covered and protected. Of course we cannot protect against a cloud-burst in this way, or probably in any other way.

I know of no other growth, or in fact anything that will protect a fill as well as willows when they have been planted long enough to obtain a good foothold. However, they must be started at the base of the embankment to do well.

TESTING TRACK COVERED WITH WATER.

M. Shea, Roadmaster.

My method of investigating where high water has covered track and where track is not very dangerous, that is, where water is not higher than two or three feet over track, is to have a man walk through the water and locate the defects in the roadbed with his feet. Where track is not too badly washed out, trains may be allowed to pass over for a thorough investigation of this kind.

Where water is cutting out embankments, destruction may be prevented by dumping in rock or getting bags of sand and dumping them into the water.

I have prevented seven washouts by dumping in steel rails against the embankments and setting ties on end and binding them with more of the rails. In the mean time we did enough filling back of them to carry traffic, where water would be washing against the roadbed.

In some cases I have piled ties up along the ends of the ties in track to keep water from washing over the roadbed.

In cases where approaches to bridges are washed out, or over holes in the roadbed, I have used ties for cribbing, placing any kind of heavy timbers on top of cribbing to form a trestle. Circumstances have a good deal to do with the handling of these matters and a thorough practical experience is of the greatest advantage in handling such matters.

EMERGENCY TRACK MATERIAL.

C. Clay.

There is no question but that emergency material should be held on each Roadmaster's district but there is a question as to what quantities should be held. This material represents money tied up and earning no dividends; on a large system there is a great outlay to cover material which is continually being held, rendering such money non-productive. Naturally this is a necessary evil, but if too much material is held, then the larger amount of money idle represents a waste in the earning capacity of capital. It is only by a constant study of the material in use that the necessary amount can be determined. If too small an amount be kept on hand, then a loss of money may be occasioned by traffic being delayed. For instance, a frog gives way at the end of a passing track at a time when there is not a spare one on hand; there is only one thing to do and that is to take out the frog, place a rail in the track and spike the switch. On double track roads, where only one switch is used to the passing track, this would mean that the track was out of service, causing trains to wait at another station, where this might have been made for an opposing or passing train. This one delay, judging by runs made, would mean other delays before the train reached its terminal. On other systems using two switches to the passing track, it would mean that trains in one direction would have to pull ahead and back in, movement in the other direction being vice versa, but in any case meaning a delay and the use of more power to cover the extra mileage and stops.

The cost of stopping a train is generally said to be in the neighborhood of one dollar in wear and tear; when this dollar is multiplied by the number of extra stops that would be made if the switch was out of service several days waiting for material, it would represent a sum, together with the increased cost for power to cover the extra movement, that would pay interest on the sum represented by emergency material for some time. There is also danger when necessary to make these extraordinary movements in operating traffic, and a collision is a costly matter. One might quote a number of instances to show that holding of emergency material is necessary, but this one should suffice. As to the exact amount of material that should be held, that is a matter

that will differ greatly with local conditions. Where the rail is mashing and breaking to a large extent, it is possible that ten rails to the mile for emergency would hardly provide a safe margin; of course this is an extreme. On the other hand, where the rail is holding up good and there are practically no breakages, one spare rail to the mile would be ample, or at the most two, distributed on the road.

In the matter of switch material one can generally see far enough ahead to obtain a frog through the regular methods, yet there is always the chance of a breakage occurring here as elsewhere, and there is this same danger with switches. There is call for spikes, bolts, joints and other track material at times, and therefore the necessity arises for keeping these on hand.

Material for ordinary repairs, practically the replacing of material worn out, should not be confounded with this emergency material. But there is a certain amount of deterioration in material which is allowed to lie unused, and whenever practicable, material received for repairs might replace the emergency material, and the older emergency material used to make the ordinary repair. A great deal of economy can be effected in the handling of this material, merely by a study of the material in the track and ascertaining what the average life of it is or what particular part shows defects. For instance, in ten miles of rail laid with a certain joint, one part of the joint has shown such defects that there are a number of breakages. It is obvious, therefore, that some spare parts of this joint must be kept on hand. Presuming that last month there were ten breaks and five the month before, fifteen will be needed for immediate replacing. If 100 are ordered, so as to have some spare parts on hand, and with an average of fifteen replacements in two months, this would mean that there would be a supply on hand to cover the breakages of thirteen months, and therefore repairs are being taken care of under the guise of emergency. Material would be held for a number of months more than was necessary, and the money invested in them would not make a return on the investment. Then again we will say that there are thirty switches of a certain style and weight of rail on a territory, and four are needed for repairs and there are none on hand. Some of the others are worn and will need renewing during the next two or three months. If a requisition is made for the whole number required there will be points laying on the ground for two or three months when this is unnecessary.

There are a number of things to take into consideration in the handling of this emergency material. If there are more left-hand turnouts than right-hand in figuring on switch points, more left-hand points should be held, as they will be more apt to suffer from breakage and wear. One important matter is that of where the material shall be stored. If the location is not more than two days' haul from a general storehouse where large supplies are kept, it is perfectly safe to keep not more than one frog of each size, two switches of each specification, two guard rails of each specification, one switch stand and other material to correspond. If located at a greater distance than a two days' haul from a general storehouse, then, of course, a larger amount of material should be held to take care of emergencies, as one would be unable to replace that used in a few days.

In going over some divisions one finds material scattered around at very station. This is another very expensive thing in connection with the handling of emergency material. While the scattered piece amounts to but little, the material on a division will amount to a large sum, as compared with emergency material kept at one place. This, of course, refers to the larger material. It is necessary to keep spikes and bolts on every section, also one or two

joints are advisable. Even with the best equipment and track in the world small accidents will happen, and where there is a tire or a pair of wheels off for a distance, spikes and bolts, and possibly a joint or two, are generally found to be needed. Therefore, it is necessary to keep these on each section. A pair of angle bars are very handy to make temporary repairs to a broken rail where there is a clear break. But the larger material, such as switch points, frogs, etc., should be kept at the terminal yard. When so kept a far less amount of material may be kept to take care of the division, and you have the advantage of always having a gang of men there that can handle it when needed. If the material is out on the road and needed elsewhere, it will probably be necessary to double gangs and get a car set at a station to load a frog, and this all means delay; and such delays are not looked on with good humor when the material is needed at once and a track is partially tied up until it reaches there.

In handling material, that kept on the wrecker should be looked on as entirely separate from the other emergency material, as this may be needed at any time, and if the habit is formed of robbing the wrecker when something is needed and there is none in sight, it may mean the tying up of a main track, even after the track is cleared, waiting for material. But only such emergency material should be carried on the wrecker as will be required to repair the main track. Figure on one main track turnout for the wrecking car, unless there is more than one standard on the division, and sufficient rails, ties, bolts and other material for a large wreck, and yet not so much that it will be a burden to haul around when there is a call for the wrecker. Material for repairs should never be confounded with this emergency material. A great deal of expense can be spared that way. Where it becomes the rule to hold a pile of material and use from it as becomes necessary for repairs, making a requisition for material to replace it, there is no certainty as to when the requisition will be filled, and sometimes there will be a shortage of that required and far more than needed of some other specification. Material for repairs should be ordered from time to time, as the rule of the particular road is, and only when the delaying of the filling of your requisition brings your material in the track to the danger point should the emergency material be used to replace it. Material should be handled in three ways and each one separate; that on the wrecker should not be used except in case of wreck, and the amount should be as small as consistent with good handling; that for emergencies should only be used when an emergency arises to require its use; that for repairs should be handled in the ordinary way by making requisition to cover a sufficient length of time ahead, but not too long, to ensure of having it on hand when necessary to change out the material in track. With the heavier material and the higher cost of such material, and, in fact, with all material, the problem is to cut down the expenses of handling, so that it will reach an irreducible minimum, and to avoid having large amounts lay idle on a railway. Certain it is that a large amount of money can be saved by a thoughtful handling of emergency material.

LABOR CONDITIONS IN THE EAST.

D. F. Harvey, Supervisor.

There are several methods of obtaining laborers for maintenance and construction work in the East. Some roads get their laborers through a labor agent, located in a large city, especially in New York, where thousands of immigrants land each year. These foreigners are transported in train loads to the points where heavy construction work is being done, or are distributed in small numbers for mainte-

nance work. Most of the roads that get their laborers in this way house them in camp cars, so that when one piece of work is completed they can move the cars and men to the next job.

On the P. & L. E. R. R. the track laborers are seldom gotten in this way and are not housed in camp cars, as we have headquarters for extra gangs at one or more points on each supervisor's division. These extra gangs go to and from work on work train, motor car or hand car. I have been handling two extra gangs, of twenty-five men each, on gasoline motor cars with push-car trailer, and I believe this is the most economical way to handle the men. I put these cars into use during June, therefore, I have not yet gotten the cost of operation per car per mile. However, I have been using a gasoline motor car, automobile type, single cylinder, four-cycle engine, on a section with a grade of 80 feet per mile, since last November, at a cost of about one cent per mile for gasoline, lubricating oil and cup grease. No repairs to car to date. This is a great saving of time and energy over the old hand-car, and the foreman has less trouble in keeping his gang full as the men did not like to work on a section where they had to pump a hand car four or five miles on an 80-foot to the mile grade.

A large percentage of our laborers have been in the service for a number of years, some as much as twenty years continuously. These old men in the service have much to do with keeping the gangs full when men are scarce as at present, and they also take an interest in their work, and when getting men to fill up the gang they always get the foreman the best men that can be found.

I make no arrangements or inducements to keep laborers satisfied and to hold the men except to treat them as men.

The laborers we have are good track men. They are mostly Italians or Austrians. The best work train gangs we have are half Italian and half Austrian.

We treat all of our men considerably, but there are a great many laborers who have to be "driven" in order to get a fair day's work out of them. Laborers who will not do a fair day's work are discharged.

The matter of greatest importance in getting track work done is, I believe, in having the gangs properly organized and in doing the work in a systematic manner. This rule holds good in any kind of work.

The head of one of the most successful contracting firms I know of, told me he had sat up nearly all night many times on large pieces of work, planning the work and working out the *proper organization of his forces*. I consider this rule the **KEY TO SUCCESS**.

PIECE WORK FOR EXTRA JOBS.

E. G. Lang, Roadmaster.

I have never had any experience with letting a contract for piece work in maintenance, but have had lots of little jobs worked out in this manner under my supervision.

I do believe that piece work in maintenance could be organized by practical men; but rather think it would be too serious an undertaking as we have so many theoretical men to deal with. I think that there are certain classes of heavy work, such as renewing ties, etc., that could be brought under piece work jobs.

I think that jobs such as track laying and relaying steel, could be brought under the contract system. There would be no objection, that I can see, to laying steel by piece work or contract, and I would think that the company would be better served from the foreman and laborers' standpoint. A foreman taking such jobs would have a great deal of advantage in procuring good laborers, as he could pay his men off daily or weekly. It would be an advantage to the company in the way of less clerical work, as the foreman would look after and care for

the men and the only reports rendered to the company by him would be as to the amount of work done and the total amount of his bill. In that case it would be simplified for the company as well as for the foreman in charge.

Another advantage would be: we would be able to get better and more efficient men to handle the business as it would be a good inducement to some of our good construction foremen.

In the past two weeks I have endeavored to get a job of widening embankments and dressing track in ballast, under the head of piece work; at first it was figured on under contract, but the officers finally agreed to the proposition of having the foreman take care of his own men and get the best of laborers, allowing him 10 per cent for supervision. The gang has not been organized as yet.

Section work and such like in my opinion could not possibly be put under piece work as our section foremen have not the clerical ability to handle such work.

SUBSTITUTING PIECE WORK FOR DAY LABOR.

P. H. Hamilton.

We have never used the piece work plan in maintenance of way or construction work on this road; but we have handled more or less renewal or construction work by contract, and it has worked out satisfactorily; but in each case the contract has covered one particular job.

The piece work system is a good thing in the factory or in the shop where each man works as a unit and produces some uniform article or does a uniform work each day, but I do not believe it would be made to cover everything in the maintenance of way department or the construction department of a railroad. It does not seem that a schedule could be worked out that would cover every kind of work, and at the same time prove satisfactory to everyone concerned. But there are a number of classes of work that could be covered and bring good results.

The piece work system could cover the building of new fences, repairing fences, painting buildings, signs, switch targets, etc.; cutting weeds, making fire guards, ditching, putting in drain tile, applying anti-creeper, applying new tie plates, etc. It could also be made to cover various forms of carpenter work. The renewal of ties could probably be covered by the piece work plan and the average cost per tie could probably be reduced, but the question is: would we be able to keep the piece workers from slighting the work so that they would not injure the line and surface of the track?

The piece work system has been tried in the mechanical department of various roads, and has proven fairly successful, but a large amount of this work is not completed as it should be and does not hold up. There are many hidden defects that the inspectors do not find, such as bolts not being tight, joints not painted, wrong kinds of nails used, dust guards omitted, nailing not complete, etc.

I believe that this fault would predominate in track work, as there are numerous ways in which the work can be slighted; and it would not be detected until the piece worker had received his pay and the inspector had gone on his way. I believe that the piece work plan would prove as successful in the maintenance of way department as it is in the mechanical department; but we would still have to maintain section and bridge gangs to maintain the line and surface of the track, to put in ties, to finish the work that the piece workers left undone, and to do the emergency jobs that arise.

I believe that bridge renewals, renewals of buildings, laying rails and other work which is generally covered by the yearly budget could be handled by contract, under the same plan that the government and municipal work is handled; and I believe that it would produce good results. Under this system, each year after the annual inspection was over, estimates could be made up and bids called for covering the different items of work of any magnitude, the work being allowed to

specifications furnished by the railway company, the contractor working under the directions of the railroad company's inspector. The contract should cover the matter of delay to traffic and should make it essential that the contractor's organization causes the minimum delay to trains; penalty for violating this clause should impose a fine on the contractor.

To bring about the operation of the piece work system in the maintenance of way department, and to make it successful, we would have to have intelligent men and experienced men for inspectors, for we would have to have very close supervision.

The piece work plan might prove more successful and make a reduction of the cost of maintenance as it is now handled; I believe, however, that a reorganization of our track, water service, signal and bridge and building departments, making them into a single organization under one head, this party in turn being under the division superintendent, is the proper thing, and will reduce the cost of maintenance.

Personals

R. R. Black has been appointed roadmaster of the Atchison, Topeka & Santa Fe Ry. at Rineon, N. M., succeeding C. L. M. McAllister. E. A. Warren has been appointed roadmaster at Canadian, Tex., succeeding W. F. Hart. O. West has been appointed roadmaster at Dodge City, Kan., succeeding W. E. Bohl.

T. F. Donahoe, formerly supervisor of track at Pittsburgh, Pa., has been appointed general supervisor of track of the Baltimore & Ohio R. R., office at Pittsburgh, Pa. D. C. McGregor has been appointed supervisor at Pittsburgh, succeeding Mr. Donahoe. M. F. Riley has been appointed supervisor of track at New Castle, Pa., succeeding F. Thornton.

J. A. Campbell has been appointed roadmaster of the Canadian Pacific Ry., Eastern division, office at Smith's Falls, Ont. A. Desharnais has been appointed roadmaster, Alberta division, at Langton, Ont. C. Fassett has been appointed roadmaster, British Columbia division, at Revelstoke, B. C., succeeding D. Rushford. E. Hall, assistant roadmaster, British Columbia division, has been transferred from Eholt Junction to Grand Forks, B. C. J. Hennessey, roadmaster, has been transferred from Three Rivers to Ste. Therese, Que., Eastern division. J. Jelly, roadmaster, has been transferred from Ottawa to Smith's Falls, Ont., Eastern division. W. Owens has been appointed roadmaster, Lake Superior division, office at Mattawa, Ont.

W. A. Todd, who was appointed general roadmaster of the Charleston & Western Carolina Ry., February 1, entered the service of this railway at the age of 20, as apprentice on a bridge gang, in 1885. He was later made bridge foreman and construction foreman, holding these positions till 1902, when he was made roadmaster at Laurens, S. C. He served in the latter capacity till his recent appointment as general roadmaster at Augusta, Ga.

J. E. Glenn has been appointed roadmaster of the Charleston & Western Carolina Ry. at Laurens, S. C., succeeding W. A. Todd, promoted.

F. W. Stiles, roadmaster of the Great Northern Ry., has been transferred from Marcus to Spokane, Wash., succeeding L. F. Wheeler, effective March 27. Fred Barnes has been appointed assistant roadmaster at Kelly Lake, Minn., succeeding G. H. Johnson, effective April 1. C. A. Bannan, assistant roadmaster, has been transferred from Essex, Mont., to Bonners Ferry, Ida., succeeding J. R. MacGarvey, effective April 1. J. Frederickson has been appointed assistant roadmaster at Moorhead, Minn. G. Carlson, assistant roadmaster, has been transferred from Great Falls, Mont., to Elizabeth, Minn. A. Eckstrom has been appointed assistant roadmaster at Great Falls, Mont., succeeding G. Carlson. E. B. Finnessey, formerly assistant roadmaster,

has been promoted to roadmaster at Marcus, Wash., succeeding F. W. Stiles, transferred. John Garrity, roadmaster, has been transferred from Whittfish, Mont., to Superior, Wis. C. Hara, assistant roadmaster, has been transferred from Devils Lake to Grand Forks, N. D., succeeding S. O. Luno. Nels Johnson, assistant roadmaster, has been transferred from Great Falls, Mont., to Moorhead, Minn., succeeding W. R. Whitby. R. S. Kniffen has been appointed assistant roadmaster at Tye, Wash., succeeding T. M. Nichols. Charles McKain has been appointed assistant roadmaster at Devils Lake, N. D. J. Martin has been appointed assistant roadmaster at Leavenworth, Wash., succeeding E. B. Finnessey, transferred. T. H. Nichols has been appointed assistant roadmaster at Spokane, Wash.

E. C. Carter has been appointed roadmaster of Denver & Rio Grande R. R. at Helper, Utah, succeeding T. Kennedy.

N. Bibby has been appointed supervisor of track of the Grand Trunk Ry. at Allandale, Ont., succeeding G. Wilson. F. Franzow has been appointed supervisor of track at Durand, Mich. J. H. Reagan, supervisor of track, has been transferred from Battle Creek, Mich., to Chicago, Ill., effective March 1.



T. F. DONAHOE, General Supervisor Track
Baltimore & Ohio R. R.

W. J. Whipple, supervisor of track of the Chesapeake & Ohio Ry., has been transferred from Pikeville, Ky., to Richmond, Ind.

J. A. Sullivan, roadmaster, Chicago, Burlington & Quincy R. R., has been transferred from Beardstown to Centralia, Ill., succeeding A. E. Bales, transferred.

E. H. Brock has been appointed roadmaster of the Chicago, Milwaukee & St. Paul Ry. at East Portal, Mont., succeeding M. Kavanaugh. G. A. Larson has been appointed roadmaster at Malden, Wash., succeeding Thomas Flynn.

A. C. Bradley has been appointed roadmaster of the Chicago, Rock Island & Pacific Ry. at Iowa City, Ia., succeeding John Hayes.

John Healy has been appointed roadmaster of the Hocking Valley R. R. at Logan, O., vice W. McCauley.

J. J. Desmond has been appointed supervisor of the Illinois Central R. R. at Water Valley, Miss., succeeding R. H. McHughes. P. J. Nolan has been appointed supervisor at Effingham, Ill., succeeding W. Robey.

B. Gorham has been appointed roadmaster of the Intercolonial Ry. of Canada at Campbelltown, N. B., succeeding James Patterson.

J. S. Harvey, roadmaster of the International & Great Northern Ry., has been transferred from Navastota to Palestine, Tex. lowest responsible bidder. The railway company should furnish the material, and the work should be done according to

T. H. Love has been appointed roadmaster at San Antonio, Tex., succeeding L. H. Smith. R. A. McDonald has been appointed roadmaster at Navastota, Tex., succeeding J. S. Harvey, transferred.

P. Christiansen has been appointed supervisor of track of the Lehigh Valley R. R. at Auburn, N. Y., succeeding James Dalton.

H. L. Busby has been appointed supervisor of the Louisville & Nashville R. R. at Birmingham, Ala., succeeding Z. B. Couch.

Roy Cantrel, roadmaster of the Missouri Pacific Ry., has been transferred from Batesville, Ark., to Aurora, Mo., succeeding J. C. Davis. C. B. Pettigrew, formerly assistant engineer, has been appointed roadmaster at Auburn, Neb., succeeding T. E. Crowley.

A. G. Chanes, roadmaster of the National Rys. of Mexico, has been transferred from Torreon, Coah., to Durango, Dgo., Mex. T. Garcia, roadmaster, has been transferred from Torreon, Coah., to Acambaro, Gto.

H. L. Barfield, roadmaster of the New Orleans, Mobile & Chicago R. R., has been transferred from New Albany to Laurel, Miss. J. L. Hegwood, roadmaster, has been transferred from Laurel to Louisville, Miss., effective April 1. A. A. Miller, roadmaster, has been transferred from Laurel to New Albany, Miss., effective April 1.

E. C. Finley has been appointed superintendent maintenance of way of the San Antonio & Aransas Pass Ry. at Yoakum, Tex., succeeding Hans Helland.

D. E. Edge has been appointed roadmaster of the Seaboard Air Line R. R. at Welden, N. C.

J. W. Welling has been appointed roadmaster of the Yazoo & Mississippi Valley R. R. at Greenville, Miss., succeeding G. F. Arthur. J. F. McNamara has been appointed assistant roadmaster at Greenwood, Miss.

George Dudley has been appointed roadmaster of the Yosemite Valley R. R. at Mercer, Cal., succeeding E. Spencer.

Among The Manufacturers

FREIGHT HOUSE DOOR HANGERS AND EQUIPMENT.

The Allith Prouty Co., Chicago, is sole agent for all goods formerly manufactured by the Allith Mfg. Co. of Chicago and the Prouty Mfg. Co., Ltd., Albion, Mich. A very extensive line of builders' hardware is being marketed by this concern, and the number of articles manufactured is constantly being increased. One of these devices is warehouse door hanger No. 6, illustrated herewith.

The warehouse door hangers and track for carrying sliding doors are strong and durable, and are recommended for use on heavy doors or doors subjected to rough treatment.

The hanger frames, lower wheels and track brackets are made of refined malleable iron, tested before leaving the factory. This assures uniform and superior quality. The upper wheel of the hanger has a hardened steel axle, bushing and washers, and roller bearings packed in high grade graphite lubricant, making the hangers anti-friction and very durable. The lower wheel, by contact with the track should the door be raised, prevents derailing and binding.

The No. 6 double adjustable hanger, with vertical adjustment of $2\frac{1}{4}$ inches and horizontal adjustment of $1\frac{1}{2}$ inches, is best for heavy doors, where such adjustability in the door hanger is desirable. The hanger is made of high-grade non-breakable malleable iron, and fitted with a large, easy-running roller-bearing upper wheel. It is designed especially for heavy parallel sliding doors, such as are used on freight stations, garages, warehouses, etc.

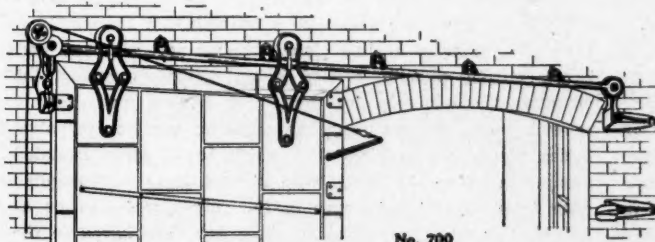
Parallel door hangers are designed for insuring perfect move-

tion, and the installation is simple. The parting strip fastened between the brackets and extending below top of door makes the equipment storm-proof as well as very strong.

The fire door, No. 700, is a tin clad fire door; two of the supports for the track are placed where they will be directly under the trolley wheels when the door is closed, thus giving maximum solidity of support when subjected to heat. It is stated that one of these tin clad fire doors, hung with Allith fire door hangers and track, was subjected to 2,000 degrees of heat for two hours and fifteen minutes. At the end of this time a stream of water under fire pressure was turned on the door. The hangers and track even after this severe test were in good condition.

This equipment is for inside or outside sliding doors or shutters, for fire wall and other openings. They are simple in construction, and easy to install.

Horizontally sliding fire doors are preferable to either vertical or swinging fire doors. They occupy practically no room, and the openings for their successful working are easily kept clear and free from obstruction.



No. 700
Fire Door Equipment.

ment of continuous parallel doors, such as used in freight stations, warehouses, etc. They are arranged to permit an opening at any place desired.

The track is assembled complete in sections to accommodate different openings. It is suitable for attaching to any construe-



No. 6. Parallel Door Hanger.

DISTILLED WATER FOR STATIONS, SHOPS AND LABORATORIES.

Aside from those in the medical profession, few appreciate the value of pure distilled water, although public interest in this matter is growing rapidly. Countless ailments are attributable to impure drinking water. Raw water, no matter how clear and sparkling, often contains disease germs, and an excess of mineral salts. Filtering water does not destroy the germs, but if properly and carefully done, it will remove a majority, but never all, of the germs. Distilled water (which is condensed steam), however, has passed through a temperature fatal to all injurious germs; and all solid matter is of course deposited during the process.

The Wagner Automatic Water Still has been developed to automatically provide distilled drinking water for passenger stations, shops, factories, passenger cars, and particularly for use in storage batteries and chemical laboratories. Two types are manufactured, one operated by steam, the other by gas.

The gas still is entirely automatic and operates continuously by simply turning on the water and gas supply. It is very simple in operation. The boiling chamber can be instantly detached for



cleaning purposes; the high goose neck prevents any physical matter from passing over with the steam under any conditions of heat below the boiler. The automatic action is simple, and the whole machine is compact and attractive in appearance. Distilled water is delivered cold, aerated and absolutely pure, direct from the apparatus. The value of such water is known to the professions and trades and its hygienic value to the consumer is beyond question.

The device is a great source of economy in the production of distilled water comparing the cost with bottled distilled water, and the cost of the machine can soon be saved in this manner. There are no parts to corrode as the entire outfit is constructed of copper and brass, heavily lined with pure block tin, and nickel plated.

The International Wagner Still Co., which is marketing the above device, has its general offices at Chicago, Ill.

New Literature

The Koehring Machine Co., Milwaukee, Wis., has recently issued Catalogue No. 18, being the 1913 edition. This catalogue is put forth in exceptionally attractive form with high grade typography, illustrations, and paper. The Foreword states in concise manner the objects in making a re-issue, and calls attention to some of the important claims made for the Koehring concrete mixer. The first few pages are devoted to a statement of the requirements of a good mixer, and to a general description of the Koehring. Following this, the book describes and illustrates in detail the different parts of the machine, in an interesting and instructive manner. All engineers in concrete work will undoubtedly be interested in this catalogue.

A MECHANICAL AUTOMATIC STOP.

By J. F. Webb.

An automatic train stop of the International Signal Company, 104 West Forty-second street, New York, consists of three divisions: a train-carried fixture, a stationary ramp, and a controlled track fixture.

It operates on the so-called "double action" principle; that is, no matter what the position of the signal blade may be, every time a train moving in the direction of traffic approaches the signal the passage of the plunger of the train-carried fixture over the stationary ramp will release the air valve, which will be instantly opened by the air pressure of the air brake system.

Then, if the signal blade is in the "proceed" position, the air valve is immediately closed by the contact member of the train-carried fixture engaging with the contact arm of the controlled track fixture, forcing the cams of the train-carried fixture to their valve-closed position, a slight blast of the air whistle notifying both the engineman and fireman that the apparatus is working properly.

But, if the signal blade is in the "stop" position, the contact arm of the controlled track fixture will have been swung out of the path of the contact member of the train-carried fixture, so that the air valve will not be re-closed and the escaping air will operate the triple valves of the air brake system and thus stop the train.

The ramp and the controlled track fixture are placed preferably at the proper braking distance in advance of the block to be protected, and are close together, the ramp being slightly in advance, for the purpose of preventing, when the signal blade is at the "proceed" position, a loss of air pressure sufficient to start the triple valves into action, so that there will be no undesired stopping of the train.

The escape of the air is regulated by an adjustable opening in the outlet pipe, so that the triple valves will give any predetermined application of the brakes, generally the "full service" rather than the "emergency;" and the escaping air operates the air signal whistle, so that the fireman and other trainmen, as well as the engineman, are instantly notified that the automatic train stop has applied the brakes.

Although there is a wide variation of operating conditions and methods on the individual railroads, the device as a whole is so flexible that slight changes of proportion, location, air piping, etc., etc., can adapt it to meet the necessities of any particular railway system; but this description is too limited to permit an attempt to enumerate here such variations and changes.

The following is a description, more in detail, of the three divisions of the automatic train stop:

1st. The train-carried fixture, which is preferably attached to the buffer beam at the front of the engine, has no electrical features, but is a purely mechanical device, consisting of an air valve in the air brake system of a train; a cam for releasing, for closing and for holding closed, the air valve; a long vertically moving plunger, carried in an oscillatory casing, for operating the said releasing cam by its upward movement; a re-setting cam for restoring the releasing cam to its valve-closed position; a locking cam, which has a spring-actuated plunger or lock co-operating with it, that locks the foregoing cams in either the valve-open or the valve-closed position as the case may be; (all of these three cams are keyed to the same shaft and move together); an oscillatory horizontal shaft, having at its inner end a second re-setting cam for actuating the first re-setting cam (when the valve is open), and, at its outer end (outside of the casing), a contact member (whose normal position is depending vertically from the shaft, and to which position it always automatically returns by reason of gravity and the assisting torsion spring) for contacting me-

chanically (not electrically) with the contact arm of the controlled track-fixture; and a weather-proof casing.

This mechanism is so designed with a "closed circuit" of air that the breakage of any portion of the valve releasing parts will permit the air to escape and operate the triple valves of the air brake system; in other words, the device is self-checking. Further, it is so designed that the breakage of any of the valve closing parts does not interfere in any manner with the releasing of the valve, but simply prevents it from being closed when it has been opened.

This fixture has also, when so desired, a manual valve-closing attachment, which may be made with a speed control. This valve-closing attachment consists of a rod, extending from the train-carried fixture to the cab and running on ball or roller bearings, which co-operates with the re-setting cam, so that a pull on the rod, when free, will close the air valve and immediately give the engineman control of the brakes through his own brake valve.

In an installation where it is desired to have the speed reduced to a predetermined point before giving the engineman this manual control, this valve-closing rod is notched, and there is inserted into the notch a mechanical latch that is operated by a governor (connected to the axle of the front driving wheels, or elsewhere if preferred), so that the rod is locked by the latch when the speed is above that predetermined point, but so that the governor removes the latch and frees the rod when the speed drops below the predetermined point. When it is desired to give the engineman immediate control regardless of the speed, the mechanical latch and the governor are omitted from this part of the installation.

2d. The stationary inclined plane, or ramp, which consists of a heavy T-rail whose table is securely spiked, or lag-screwed to approximately ten ties, and whose leg is divided into two gradual slopes meeting in a high point that is approximately five inches above the top of the track rail; the distance of the center of the leg from the gauge line is determined by the conditions which have to be met on the particular railroad where the device is being installed, generally somewhere between twelve and eighteen inches outside the gauge line.

The function of this ramp is to push the vertical plunger upward and release the air valve, so that it can be opened by the air pressure in the train line pipe, every time the train passes over the ramp in any train movement in the direction of traffic; but in any train movement opposite to the direction of traffic, the ramp simply oscillates the plunger carrier so that the plunger is not moved vertically and the valve is not released.

3d. The controlled track fixture is practically a dwarf electric automatic block signal, as far as the interior mechanism is concerned, except that a 50-pound weight, hung on a horizontal shaft journaled in ball bearings, is the motive power that swings the heavy contact arm to the "stop" position. This contact arm is a sturdy metal arm approximately thirteen inches long, and analogous to the semaphore blade of the said automatic signal, but moves in a horizontal, instead of a vertical plane. It is supported and carried by a heavy vertical shaft, and is the only portion of the fixture that is outside of the enclosing weather proof iron shell that protects the mechanism. The horizontal shaft and the vertical shaft co-operate with each other through the meshing of two sturdy 45-degree spiral gears, one on each shaft.

When the contact arm is in the "proceed" position, this 50-pound weight is held suspended at an angle of 90 degrees by means of an electrical latch of the well known "slot device" type that is controlled by a closed electrical circuit which passes through a contact point on the armature of a track relay (where a track circuit is in use), or through a switch operated by the oscillation of the blade shaft of a signal, or through both the said contact point and switch, which gives our automatic train stop all of the well known advantages (such as protection against broken rails, open switches, etc.), that are derived from

a track circuit, and also the advantages that are derived from working synchronously with the signal blade.

The use of the closed circuit provides protection against insufficient connection with the controlling device, broken wires, worn out batteries, and all forms of careless or negligent maintenance. The maintenance of this track fixture, however, is under the jurisdiction of the skilled signal maintainer, and is, therefore, as carefully looked after as that of the signals themselves.

In this connection, attention is called to the fact that any improper maintenance, or the breakage or removal of the contact arm or the weight or the parts attached thereto, can never result in allowing a train to proceed when it should stop, though it may sometimes stop a train when it might have been safe for it to proceed.

As the master gear is loosely mounted on the weight shaft, which, as stated above, is journaled in ball bearings, the 50-pound weight, in dropping from the "proceed" to the "stop" position, does not move any of the gearing from the master gear to the motor, nor does it rotate the motor armature, being entirely independent of both; and this construction renders it impossible for the contact arm to be frozen or otherwise stuck in a false "clear" position. This is one of the strongest and most valuable features of this device, and was particularly examined by the Block Signal and Train Control Board and by its inspectors.

This controlled track fixture is so constructed that its contact arm is "rigid yet flexible." By reason of the gravity of the 50-pound weight, it is held rigid enough to actuate the contact member of the train-carried fixture; but, when it is struck accidentally by any abnormal train-carried obstruction (such as a swinging freight car door, a projecting lumber stake, etc., etc.) it is readily movable out of the path of such obstruction, and the weight immediately returns it to its contacting position after the abnormal obstruction has passed.

Having once reached the "stop" position, an automatic safety latch, which is mechanically operated, prevents the contact arm from being moved to the "proceed" position until the protected block is clear and safe; and the 50-pound weight is lifted and the contact arm moved to the "proceed" position only after the circuits have been restored through the motor and the magnets of the "slot device" and the moving gears have released the said safety latch.

This controlled track fixture is located approximately three feet seven inches from its center to the gauge line, and the top of the contact arm is approximately nineteen inches above the top of the track rail. The device is mounted on long ties, so that its proper relation to the track is always maintained, regardless of any settling or heaving of the latter.

Industrial Notes

W. F. Hebard, 1200 Karpen Building, Chicago, has taken over the district sales agency for the electric shop and baggage truck department of The Buda Co. He also continues to handle the local business for the Canton Culvert Co., Canton, O., manufacturers of the well-known "Acme" (nestable) corrugated culvert pipe.

The Roadmasters & Maintenance of Way convention will be held in the Auditorium Hotel, Chicago, Ill., Sept. 9, 10, 11 and 12, 1913.

W. W. Coleman, who has for the past 5 years been in the estimating department of the Union Switch & Signal Co., Swissvale, Pa., with office in New York, has resigned that position to go to the Edison Storage Battery Co., Orange, N. J., as sales engineer.

The Illinois Central has ordered 18 coaches, 6 postal cars, 13 combination mail and baggage cars, 3 dining cars and 3 express cars from the Pullman Co. Of this order, 8 coaches, 3 express cars and 3 combination mail and baggage cars are for the Central of Georgia.



Recent Engineering and Maintenance of Way Patents

LOG BUNK FOR CARS.

1,058,053—G. L. Hale, Assignor to the Hale-Mylrea Lumber Co., Wausau, Wis.

This device has a timber adapted to be disposed transversely of a flat car with a pair of plates secured upon opposite sides of the timber, at each end thereof, the plates projecting beyond the ends of the timber to form stake receiving pockets, each of the plates being provided with a notch in the upper corner of its free end, links having one end pivotally supported by one plate of each pair and being adapted to rest in the notches, each of the links being provided at one end thereof with a latch having a hole adapted to receive a pin carried by one of the plates and a locking lever operable from the opposite end of the timber adapted to lock each of the latches in engagement with its co-acting pin.

ANTI CREEPER.

1,058,127—Benjamin Wolhaupter, New York, N. Y.

4. An anti-creeper device, comprising a pair of rail-embracing clips that engage over the opposite base flanges of a rail, and means for causing the bodily longitudinal sliding and convergent movements of the clips diagonally of the rail upon the attempted longitudinal movement of the rail.

APPARATUS FOR GRADING GRAVEL OR OTHER MATERIALS.

1,058,161—R. W. Dull, Aurora, Ill.

Apparatus for sizing and grading material, comprising a conveyor belt arranged to travel horizontally, adapted to support the material thereon, and a number of trippers disposed in the path of travel of the belt, adapted to successively intercept the material thereon, each tripper being provided with a sizing mechanism, the mechanism of each tripper comprising a screen, and the screens of the trippers being of different character, each tripper being movable to intercept the load at different points in the length of the belt.

SELECTIVE SIGNALLING SYSTEM.

1,058,176—W. E. Harkness, East Orange, N. J.

1. A signaling system, comprising a line having a plurality of stations, a selector in a closed bridge of the line at each of the stations, an electromagnetically operated signal in a normally open bridge at each of the stations, the last named bridge being adapted to be closed by the operation of the selector, variable resistance means in each of

STATEMENT AS TO THE OWNERSHIP AND MANAGEMENT OF RAILWAY ENGINEERING AND MAINTENANCE OF WAY, IN ACCORDANCE WITH ACT OF CONGRESS, AUGUST 24TH, 1912.

Railway Engineering and Maintenance of Way is published monthly at 431 South Dearborn St., Chicago, Ill.

The officers are as follows:

President—William E. Magraw, 431 So. Dearborn St., Chicago.
Editorial Director—L. F. Wilson, 431 So. Dearborn St., Chicago.
Editor—Kenneth L. Van Auker, 431 So. Dearborn St., Chicago.
Business Manager—C. C. Zimmerman, 431 So. Dearborn St., Chicago.

Publisher—The Railway List Co., 431 So. Dearborn St., Chicago.
Those holding stock to the amount of one per cent or more are as follows:

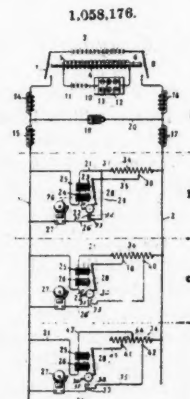
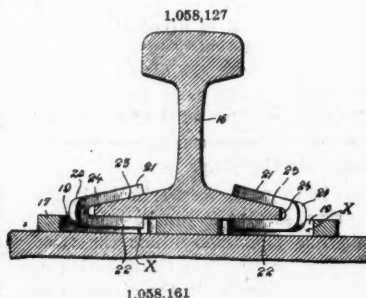
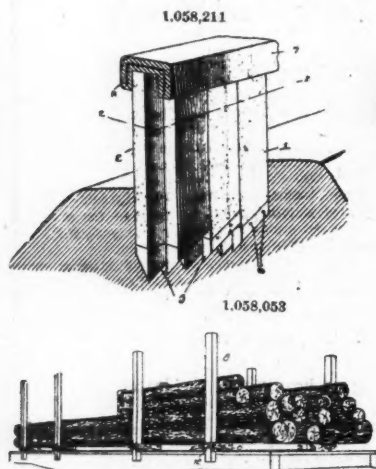
W. E. Magraw, 431 So. Dearborn St., Chicago.
C. S. Myers, 50 Church St., New York.
H. H. Schroyer, 38 So. Wabash Ave., Chicago.
C. A. Dunkleberg, Ft. Wayne, Ind.
E. C. Price, Springfield, Ohio.
H. U. Morton, 140 So. Dearborn St., Chicago.
J. S. Bonsall, 26 Cortlandt St., New York.
G. H. Williams, Rockefeller Bldg., Cleveland, Ohio.
P. S. Smith, 434 So. Green St., Chicago.
J. T. McGrath, Bloomington, Ill.
K. L. Van Auker, 431 So. Dearborn St., Chicago.
J. M. Crowe, House Bldg., Pittsburgh, Pa.
J. E. Chisholm, Old Colony Bldg., Chicago.
Those holding bonds to the amount of one per cent or more are as follows:

W. F. Hall Printing Co., 446 W. Superior St., Chicago.
Cozzens & Beaton, 443 Plymouth Court, Chicago.
Bradner Smith & Co., 175 W. Monroe St., Chicago.
Harry C. Lewis, New York, N. Y.
Geo. H. Holt, 431 South Dearborn St., Chicago.
Myron C. Clark Publishing Co., 612 So. Dearborn St., Chicago.
Mrs. Jessy Hazleton, 446 W. Superior St., Chicago.
(Signed)

WILLIAM E. MAGRAW, PRESIDENT.

Sworn to and subscribed before me this 28th day of March, 1913.

(Signed) Robert R. Grieg, Notary Public.
(My commission expires Oct. 26, 1915.)



the bridges, and means for changing said variable resistance in one of the bridges when the normally open bridge is closed by the selector.

CULVERT.

1,058,198—J. H. Schlafly, Assignor to The Canton Culvert Co., Canton, Ohio.

5. A culvert comprising complementary sections having their lateral edges overlapped, one of the sections provided with bolts extending through its lateral edge and the other section provided with circumferentially disposed slots in its lateral edge, the slots opening through the edge and adapted to slidably receive the bolts.

REINFORCED CONCRETE RETAINING WALL.

1,058,211—H. D. Whipple, Brooklyn, N. Y.

2. A reinforced concrete retaining wall formed of a number of piling units staggeredly arranged, each unit having an obliquely cut-off beveled penetrating point, the bevel of the points of the right units being reverse to the bevel of the points of the left units.

The Carolina & Georgia, it is reported, has awarded a contract to M. P. McGrath, Worcester, Mass., for the construction of a new line to extend from Augusta to Columbus, a distance of 75 miles.

The Brinson is reported to be planning the extension of its line through Thomson to Washington, Ga.

The contract for the construction of 406 miles of railroad on the Central Canadian line extending from Montreal to Ottawa and the Great Lakes, has, according to reports, been awarded to M. P. McGrath, of Worcester, Mass.

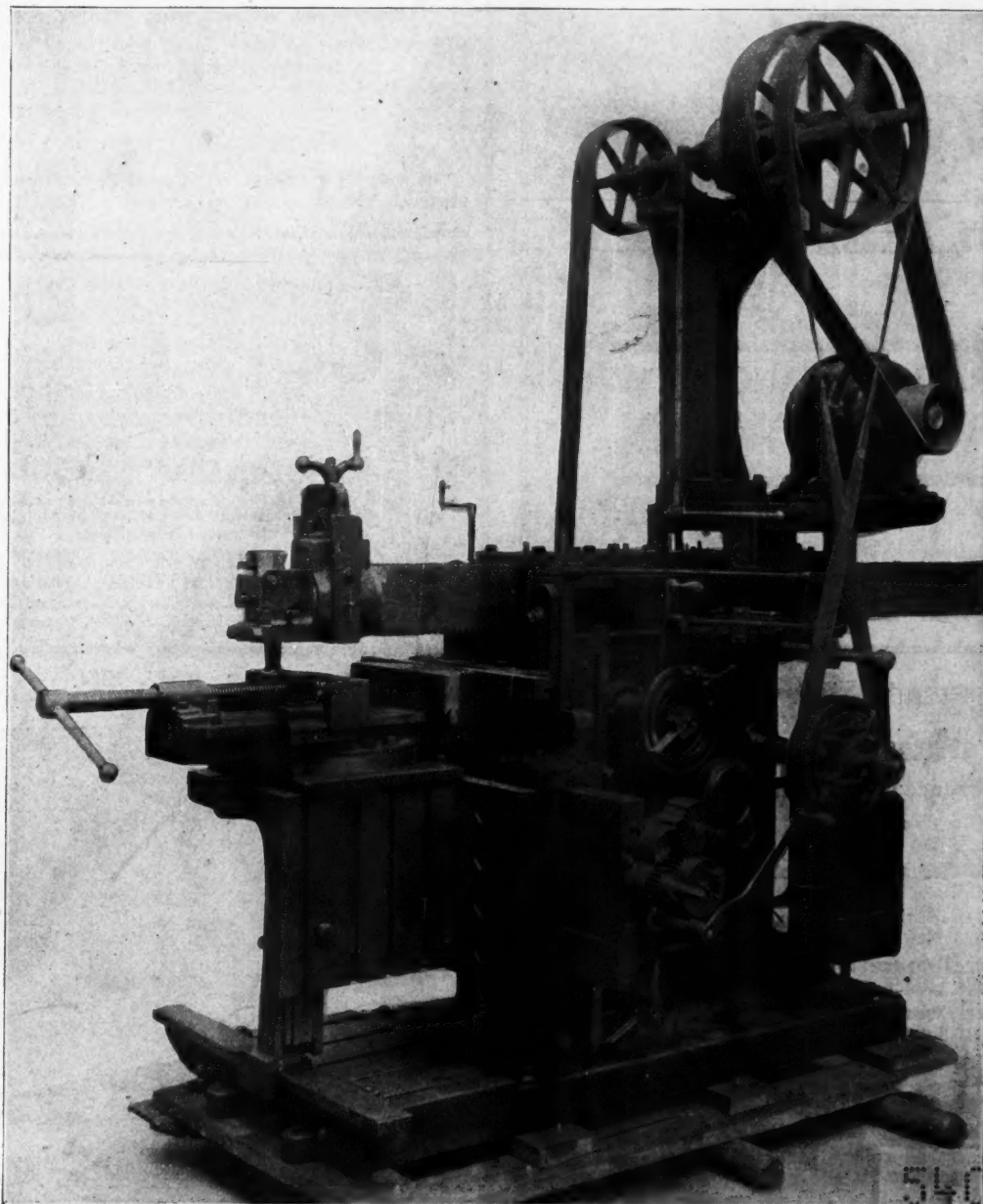
The Copper Range is said to have decided definitely to build a 5-mile branch, starting from a point 2½ miles north of Toivola to Painesville, Mich.

The Chicago, Burlington & Quincy has awarded the contract for team work in connection with the construction of a third track from Galesburg to Wataga, Ill., to J. J. McCaughey, Chicago, Ill. The steam shovel work will be done by the railroad itself. The work will cost about \$250,000.

The Kansas City, Mexico & Orient has finished work on the extension from Fort Stockton, Tex., to Alpine, 63 miles, and it is now open for business.

MORTON DRAW CUT SPECIAL FROG AND SWITCH SHAPER 48" STROKE

Will accomplish a large variety of work at a great saving over ordinary methods.



IT is BUILT ESPECIALLY FOR THE WORK and has a SPECIAL HEAVY VISE for HOLDING RAILS FOR NOTCHING.

The RAM and HEAD are made of STEEL.

It has a RAPID POWER TRAVERSE MOVEMENT FOR ELEVATING THE CROSS RAIL and MOVING THE APRON SIDE WAYS for adjustment.

The STRONGEST, Most POWERFUL and EFFICIENT SHAPER BUILT.

Some of the large Manufacturers of Frog and Crossings have from TWO to SIX of these machines in operation.

BUILT and guaranteed by THE SAME COMPANY who make the SPECIAL 32" RAILROAD DRAW-CUT SHAPER.

ALSO builders of DRAW CUT CYLINDER PLANERS.

MORTON MANUFACTURING COMPANY,

Muskegon Heights, Mich.

WRITE FOR BULLETIN NUMBER TEN

ESTABLISHED 1882



Weir Frog Company

RAIL and MANGANESE
TRACK WORK

Cincinnati, Ohio

BROADWAY CENTRAL HOTEL

Broadway, corner Third Street

IN THE HEART OF NEW YORK

Only Medium Price Hotel left in New York.

Special attention given to ladies unescorted

SPECIAL RATES FOR SUMMER

OUR TABLE is the foundation of our enormous business.

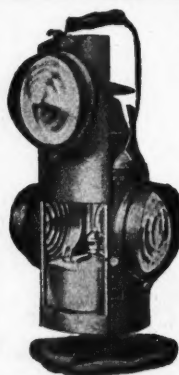
AMERICAN PLAN, \$2.50 UPWARDS

EUROPEAN PLAN, \$1.00 UPWARDS

Send for Large Colored Map of New York, FREE.

DAN. C. WEBB, Proprietor

The Only New York Hotel Featuring American Plan
Moderate Prices. Excellent Food. Good Service.



LANTERNS

SWITCH, ENGINE,
SIGNAL, SEMAPHORE,
MARKER, STATION, Etc.

CHIMNEYLESS BURNERS

for one day and long-burning service

30 YEARS' EXPERIENCE

New and specially equipped factory enables us to fill large orders promptly and at fair prices.
Illustrated catalogues on request.

PETER GRAY & SONS, Inc.

Mall Address: "Cambridge", BOSTON, MASS.

Chicago Office: 303 Great Northern Bldg.

JOSEPH M. BROWN, Representative.

Round Body Steel Switch Lantern

The Massee Country School

Lawrence Park, Bronxville, New York

Telephone, 257 Bronxville

A boarding and day school for boys from 6 to 19 years.

Located in beautiful Westchester County, thirty minutes from New York City.

Junior Department prepares thoroughly for Hill, St. Paul's, Exeter, and for all large boarding schools.

Senior Department prepares for all the leading colleges, scientific schools, West Point, and Annapolis.

Real individual instruction; classes limited to six members.

Bright pupils not retarded. Backward pupils not discouraged and properly graded.

Teachers all college graduates of at least three years' experience.

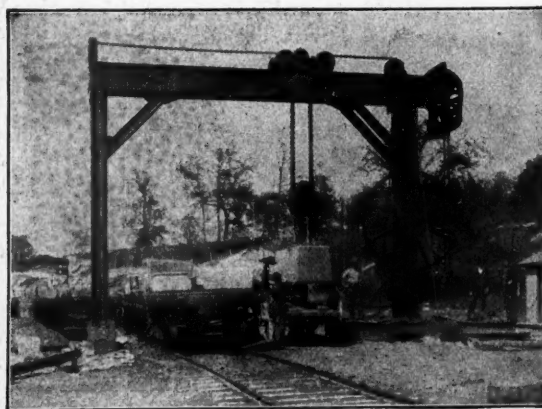
Exceptional facilities for athletic sports and all forms of outdoor life under the supervision of the Masters.

A prominent Wall Street Attorney writes: "From your excellent methods my son did substantially two years' work in one at your school, thus entering college one year ahead of time."

A Princeton Professor writes: "Some of our finest Princeton students were former pupils of yours." For illustrated catalog, address

W. Wellington Massee, Ph. D.

Box 200 - - - Bronxville, N. Y.



Brownhoist Bridge Crane

is an inexpensive and durable machine for handling all heavy loads from car or wagon with just one or two men. Being equipped with safety appliances, it practically eliminates all danger to the men.

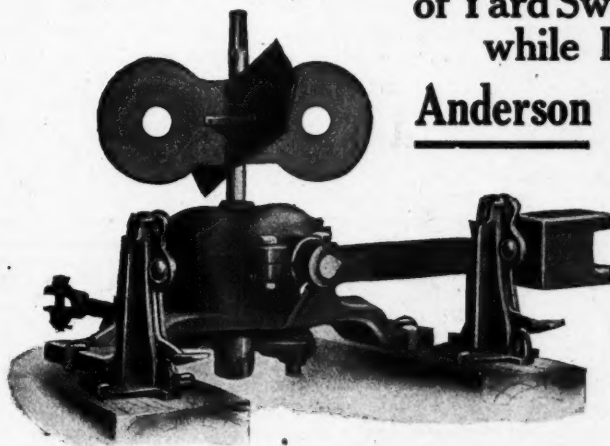
Write for our new catalog J on bridge cranes.

THE BROWN HOISTING MACHINERY CO.
CLEVELAND, OHIO

New York Pittsburgh Chicago San Francisco

16²/₃ CENTS

**Maximum
Maintenance Cost
of Yard Switches that are Run Through
while Latched if you use the
Anderson Economy Switch Stand**



This stand for yard switches, is provided with a special 3 way crank arm made of malleable iron. This 3 way crank arm is designed that when switch is run through, one of the arms to which the switch is connected will shear off, without damage, to any part of the switch mechanism.

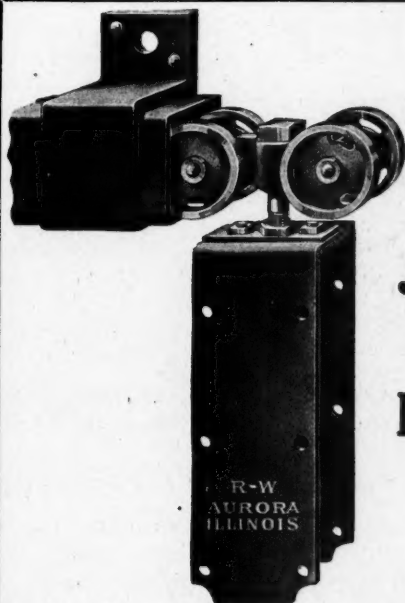
The switch can be quickly placed in order by connecting the rod to one of the other arms. When the three arms are destroyed a new three way crank can be applied. These are furnished at 50 cents each. This feature is not new.

Over 30,000 Economy switch stands with this special 3 way crank, in service on many railroads. Nonbreakable cranks are furnished for main line switches.

Full Details and Description of This Switch Stand in Our Catalogue. Write for It

MANUFACTURED EXCLUSIVELY BY

THE AMERICAN VALVE AND METER COMPANY
CINCINNATI, OHIO



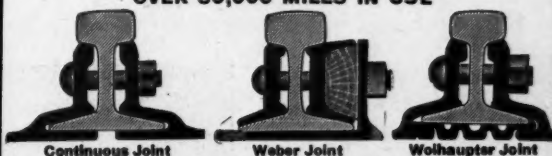
No.
150¹/₂ B
**Jumbo
Door
Hanger**

You have all lived long enough to know that competing articles made to fulfill the same need vary in their extent of filling that need. Some fill it half ways; some three-quarters; some all the way. Specify **RICHARD-WILCOX** Door Hangers; they fill the need all the way.

Architect's Catalog No. 10 on Request

Richards-Wilcox Mfg. Co.
125 THIRD STREET AURORA, ILLINOIS

OVER 50,000 MILES IN USE



ROLLED FROM BEST QUALITY STEEL

The Rail Joint Co. General Offices: 185 MADISON AVENUE, NEW YORK CITY

Makers of Base-Supported Rail Joints for Standard and Special Rail Sections, also Girder, Step or Compromise, Frog and Switch, and Insulated Rail Joints, protected by Patents.

CATALOG AT AGENCIES

Boston, Mass.; Chicago, Ill.; Denver, Colo.; Pittsburgh, Pa.; Portland, Ore.; St. Louis, Mo.; Troy, N. Y.

Locomotive Boiler Washout Plants

For Roundhouses

STEAM AND ELECTRIC POWER PLANTS INSTALLED
COMPLETE—HEATING AND GENERAL PIPE WORK
—OLD PLANTS REPAIRED AND REBUILT

INCREASED ECONOMY AND EFFICIENCY OUR SPECIALTY

As Pioneers in This Line Our Experience Should
Be of Value to You

GALE INSTALLATION COMPANY
ENGINEERING - CONSTRUCTION

McCormick Building, Chicago, Illinois

RAILWAY ENGINEERING

AND MAINTENANCE OF WAY



Cook's Magic Tool Grinder

It is geared high. The gears are all enclosed, and are kept free from dirt. The patented holder makes it possible for any laborer to correctly sharpen a drill bit; simply place the bit in the holder and swing to and fro against the wheel. The holder can be adjusted to give any clearance to the bit point.

Complete description in our catalogue—Write for it.

COOK'S STANDARD TOOL CO., KALAMAZOO, MICH.
U. S. A.

M. C. B. Co., McCormick Bldg., Chicago
Western Agents

Space 51, Coliseum
H. M. BUCK, 30 Church St., N. Y.
Eastern Agents

THE JOHNSON CAR REPLACER

Range and capacities of
the different types
are as follows:

Type M for rail 12 - 45 lbs.
Type C for rail up to 65 lbs.
Type B for rail up to 80 lbs.
Type A for rail up to 100 lbs.
Type Z for rail up to 100 lbs.

If Not Over
3½ Inches high
4½ Inches high
5 Inches high
5½ Inches high
6 Inches high

Capacity.
20 Ton Locomotive
30 Ton Locomotive
50 Ton Locomotive
80 Ton Locomotive
100 Ton Locomotive

Throat Opening.	Wt. Each.
2 Ins.	30
2½ Ins.	60
3½ Ins.	110
3½ Ins.	145
3½ Ins.	165

THE JOHNSON WRECKING FROG COMPANY, CLEVELAND, OHIO

Read the Ads

WANTED An experienced man for water service work by Railway Company. Railway experience not necessary, but experience in the maintenance of pumps and water piping required. Technical training not essential. Duties will be largely outside of office. Address—"Railway Engineering."

THERE IS NO



Copyright 1912, by J. W. Stonehouse, Denver, Colo.

Of Mistaking the Meaning of This Sign

The word DANGER appears in white on a brilliant red oval set on a black background.

The color combination is striking—it immediately conveys a warning, and its brilliancy and sharp contrasts compel attention.

It is cheaper to install this sign than to install a wooden one; in fact it's cheaper to install a new Universal sign than to pay for maintaining an old wooden one. Universal signs will not chip, crack, rot or fade, and they are so well protected by the enamel that they will practically never rust. The colors and letters are burned on, and they will stay on. Weather and smoke does not dim the brilliancy of these signs.

Our manufacturing facilities enable us to make these signs in quantities and allow us to quote surprisingly low prices. These three considerations—the brilliancy and sharp contrasts which compel attention—the durability—and the low price—have set in motion a campaign to make the Universal the Standard danger sign. We will be glad to send you, without charge, a full sized print of the Universal in colors, and furnish prices.

We can also quote some very attractive figures on special enameled signs and notices for platforms, crossings, culverts, bridges, waterways, cattle passes, third rails, slow speed sections, whistle posts, yard limits and siding.

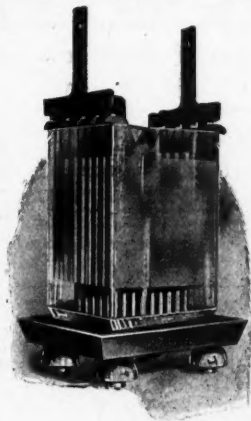
Let us figure on your requirements.

The Stonehouse Enameled Steel Sign Company
907 EIGHTEENTH STREET :: :: DENVER, COLO.



Storage Batteries For Signal Service

U-S-L batteries discharge only when the signal circuit is closed. Although the service be extremely intermittent they retain their capacity—no energy being dissipated uselessly by internal discharge. This desirable feature is secured by our advanced methods of manufacture and the absolute purity of our raw materials.



The U. S. Light & Heating Co.

GENERAL OFFICES: 30 Church Street, New York

FACTORY: Niagara Falls, New York

BRANCH OFFICES AND SERVICE STATIONS:

New York

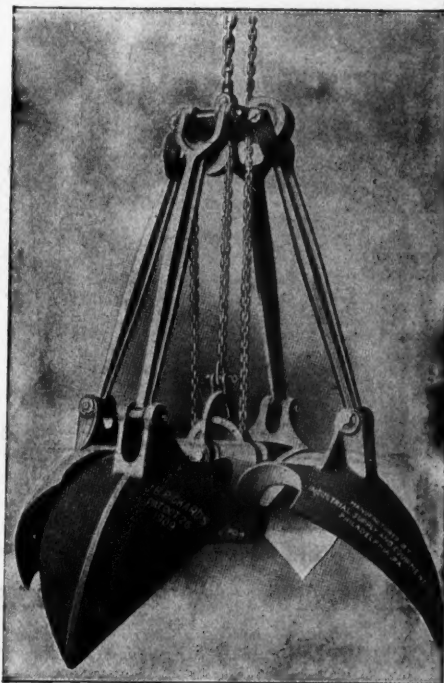
Boston

Buffalo
St. Louis

Cleveland
San Francisco

Detroit

Chicago



THE BUCKET

And What the Owner Says

"The first thirty days we operated your three yard bucket we received an excess check of \$2,700."

If you are any judge at all, look at above and look at the design of our

All Cast Steel Orange Peel Bucket

The Best on the Market. Costs No More

WRITE US

The Industrial Supply & Equipment Co.

407 Sansom Street, Philadelphia, Pa.

Agents—J. E. CHISHOLM, 350-55 Old Colony Building, Chicago
FRANK D. MOFFAT & CO., New York and Boston

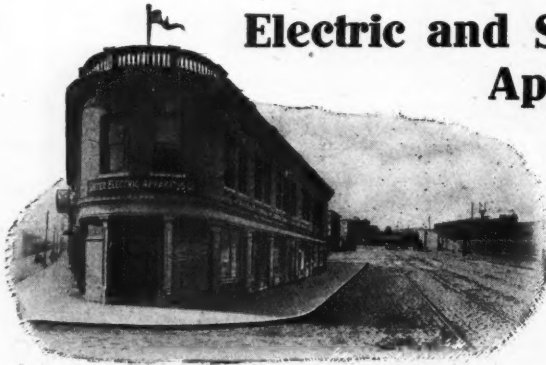
Our guarantee, "more yards per day under like conditions than with any other bucket."

United Electric Apparatus Co. Inc.

A. A. ZIEGLER, General Manager

Est. 1880

Engineers, Manufacturers, Designers and Contractors



Electric and Steam Railway Signaling Apparatus and Accessories

Sole authorized manufacturers of the PAT. and PAT. applied for line of perfected united contact and interchangeable apparatus of modern types.

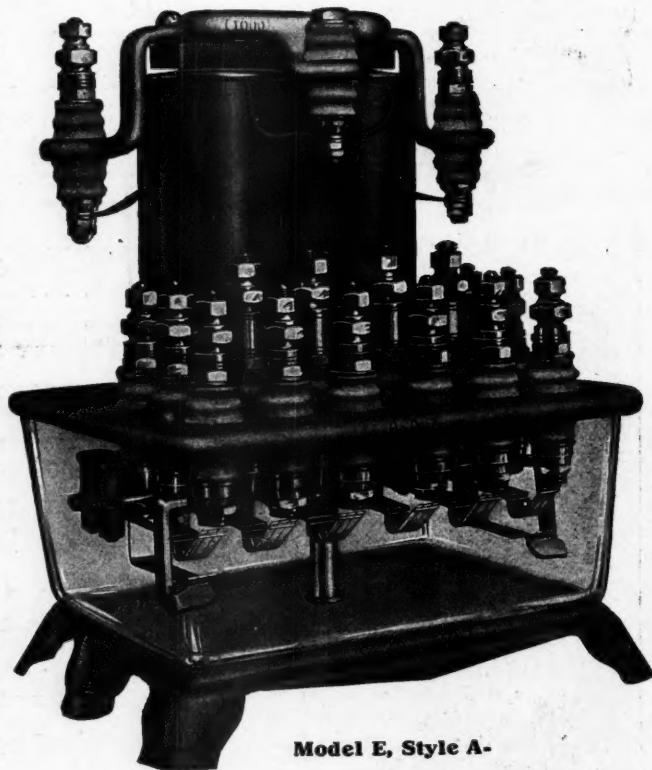
Originators of all Bracket Type Relays, all Electric Automatic Time Relays. PAT-ENTED and PAT. PENDING.

Our apparatus meets all the requirements of the Railway Signal Association.

We manufacture for D. C. and A. C. All forms open and enclosed track and line relays, keys, switches, repeaters, indicators, annunciators, lightning arresters, crossing, tower and call bells, and a general line of accessories and supplies.

Repairing Promptly Executed

Special Apparatus Built to Order



Model E, Style A-

Main Office and Factory, 1529-1533 Columbus Ave., Boston, Mass.

Branch Office and Agency

30 Church Street, Hudson Terminal, New York City

Signal Accessories Co.



1

2

LOOK OUT THERE! SHE'S BROKEN AWAY!

SAUNDERS CAR STOPPER

Has demonstrated by Service Test that a train of eight loaded cars on level track at speed of eight miles an hour was fully stopped when third corrugation was reached.

WE BELIEVE IT SO THOROUGHLY THAT WE OFFER TO INSTALL THEM SUBJECT TO YOUR APPROVAL AFTER TEST TRIAL

1 SHOULD WORRY IT! (CARRIED BEHIND A SAUNDERS STOPPER)

WELL I'LL BE JIGGERED!

AUTOMATICALLY PERFORMS THE FUNCTIONS OF AN EMERGENCY BRAKE WITHOUT DAMAGE TO TRACK, STOPPER OR CAR EQUIPMENT NO MATTER WHAT THE SPEED.

SOUTHERN RAILWAY SUPPLY CO., MFR'S & SALES AGT'S 113 N. SECOND ST. ST. LOUIS, MO.

STEEL FENCE GATES FOR RIGHT OF WAY

\$2.75

For This 10 ft. x 4 ft. Steel Fence Gate
Able to Swing Five Men and LAST You TWENTY YEARS.
Easily Handled. Cannot Burn or Rot. Non-Breakable.
Cattle Proof.

Board Gates are Expensive.

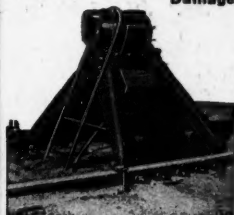
Write today and learn the secret of our remarkably low price. Ask for a list of users. Prices on any length quoted on request. Present output, 30,000 gates a year. Let us SAVE MONEY FOR YOU.

IOWA GATE COMPANY, RAILWAY DEPARTMENT, CEDAR FALLS, IOWA



WE WILL HELP YOU STAND THE HARD BUMPS

One Million One Hundred Thousand Foot Pounds Shock Without Damage to Cars or Posts



Hercules Steel Bumping Post
Heavy Freight Type No. 1

Railway & Traction Supply Co.,
RECTOR BUILDING, CHICAGO

NOW IN USE ON

Penna.—L. S. & M. S.—C. & N.
W.—Panama Canal—Southern—
C., M. & St. P.—C. R. R. of N.
J.—Ill. Northern—D. & H.—
Hock. Valley—Seaboard A. L.—
L. & N.—Brooklyn Rapid Trans-
sit—Northwestern Elevated—
Georgia R. R.—Southern Pacific
—A., T. & S. F.—C., St. P., M. &
O., and many others.

WHY NOT ON YOURS?

Sole Manufacturers—Hercules
Steel Bumping Post for Passen-
ger, Freight or Elevated Service
Wyoming Vacuum Trunk Sander
Wyoming Automatic Curtain Release



THE FRICTIONLESS RAIL

687 Atlantic Avenue, Boston

Interesting to all Railroad Men

12 STOPS

- STOPS—Excessive thrust & lateral pressure on high rail.
- STOPS—Cutting on wearing edge of high rail.
- STOPS—Climbing on high rail.
- STOPS—Elbowing of joints on high rail.
- STOPS—Excessive vertical wear on low rail.
- STOPS—Flowing of metal on head of low rail.
- STOPS—Outward rolling of both rails.
- STOPS—Rapid cutting-in of ties.
- STOPS—Excessive wear of wheel flanges.
- STOPS—Squealing and grinding.
- STOPS—Lateral motion of engine and coaches.
- STOPS—The necessity of applying brakes to steady train around curves.

All of above proved by actual demonstration

F. A. BARSEY, Trustee S. W. SIMONDS, Treas.

ANTOX

ANTOX is the name given to a series of protective paints.

These paints are absolutely Water, Brine and Corrosion proof.

ANTOX Coatings withstand solutions as virulent as 35% Sulphuric Acid or Caustic of Potash.

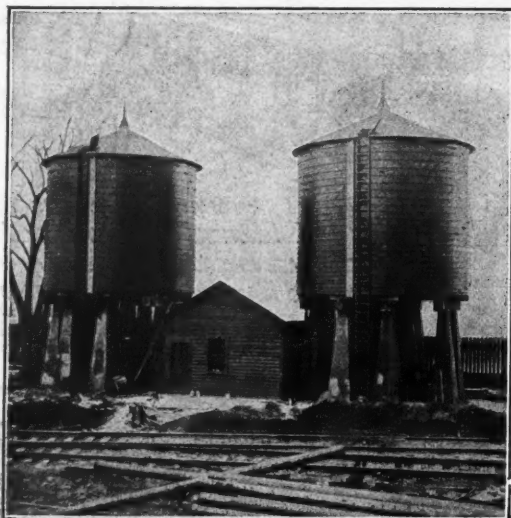
ANTOX paints are specialized to meet the exacting demands of modern steel rolling stock and specific industrial needs.

ANTOX PAINT CO.

Sole Manufacturers, Indianapolis, Ind., U. S. A.

New York Office

18 Broadway



INTERMITTENT SOFTENER

SOFTENERS

Continuous — Intermittent

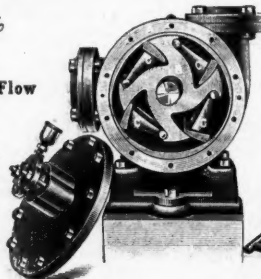
Gravity--- **FILTERS** ---Pressure
PITTSBURGH FILTER MFG. CO.
 Kansas City PITTSBURGH Chicago

Pump Water at Less Cost The Blackmer Rotary Pump

Especially Adapted to Water Tank Installation

75 to 80%
Efficiency

Continuous Flow

Made in
sizes with
capacities
of from
5 to 500
gals.
per
minute.20% added
Efficiency
for Given
PowerMade in either
Bronze or
Iron as
Conditions
Warrant

Principal Wear Comes on Detached Buckets

Which can be replaced without disturbing connections

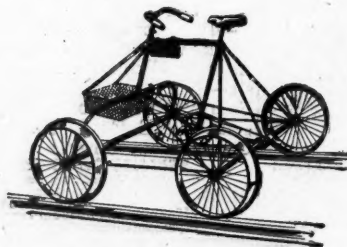
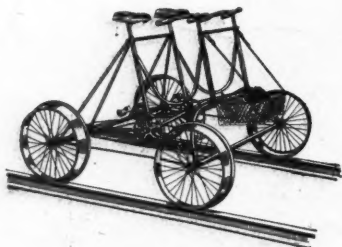
Repair Parts Obtainable at Their Proportionate
Cost to the Assembled Whole

Made in single or double direct connected units

Let Us Figure on Your Next Installation

Blackmer Rotary Pump Power & Mfg. Co.
 Petoskey, Mich.

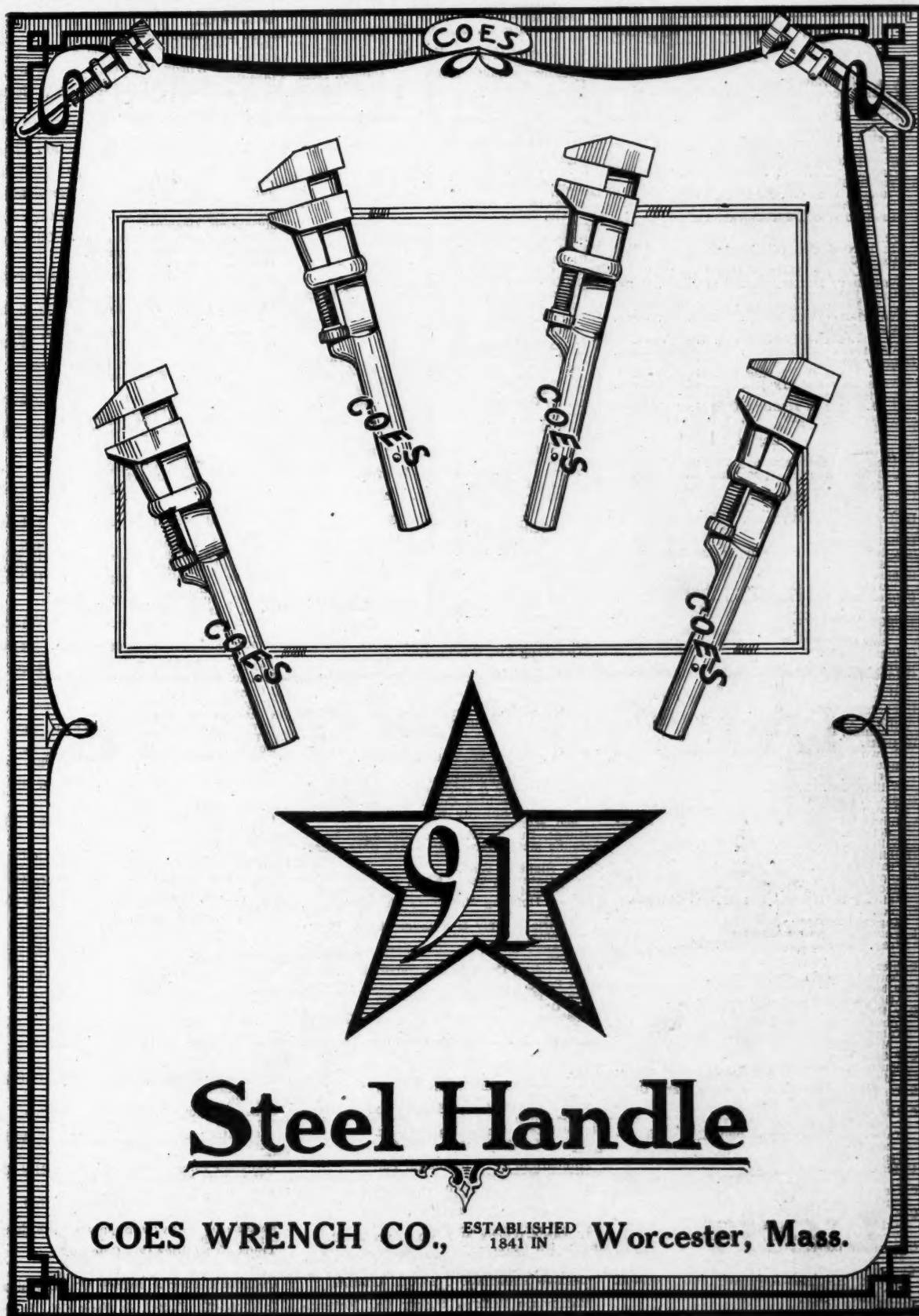
HARTLEY & TEETER



Light Inspection Cars are the Strongest and Lightest running known. The fact that we constantly receive repeat orders is proof absolutely that our cars are giving entire satisfaction. We shall be pleased to supply you with our new catalog that tells all about them.

LIGHT INSPECTION CAR CO.

HAGERSTOWN, INDIANA



COES

COES

COES

COES

91

Steel Handle

COES WRENCH CO., ESTABLISHED 1841 IN Worcester, Mass.

CLASSIFIED INDEX OF ADVERTISERS

- Adjustable Bridle Rods.**
Track Necessities Co., Chicago.
- Annunciators.**
United Electric Apparatus Co., Boston, Mass.
- Asbestos Products.**
Franklin Mfg. Co., Franklin, Pa.
- Asbestos Roofing Slates.**
Franklin Mfg. Co., Franklin, Pa.
- Asbestos Sheathing.**
Franklin Mfg. Co., Franklin, Pa.
- Axle Washers.**
Hubbard & Co., Pittsburgh, Pa.
- Bars.**
Hubbard & Co., Pittsburgh.
- Battery Cells.**
U. S. Light & Heating Co., New York.
- Waterbury Battery Co., Waterbury, Conn.**
- Battery Renewals.**
U. S. Light & Heating Co., New York.
- Waterbury Battery Co., Waterbury, Conn.**
- Battery Supplies.**
U. S. Light & Heating Co., New York.
- Waterbury Battery Co., Waterbury, Conn.**
- Battery Zincs.**
U. S. Light & Heating Co., New York.
- Waterbury Battery Co., Waterbury, Conn.**
- Batteries, Electric.**
U. S. Light & Heating Co., New York.
- Waterbury Battery Co., Waterbury, Conn.**
- Belle Isle Motor Cars.**
Concrete Form & Engine Co.
- Bells.**
Hoeschen Manufacturing Co., Omaha, Neb.
- United Electric Apparatus Co., Boston, Mass.**
- Boiler Washout Plants.**
Gale Installation Co., Chicago.
- Boils, Nuts and Washers.**
Hubbard & Co., Pittsburgh.
- Bonding Drills.**
Kalamazoo Railway Supply Co., Kalamazoo, Michigan.
- Books.**
Clarke, Myron C., Pub. Co., Chicago.
- Bridge Rods, for Track Laying.**
Track Necessities Co., Chicago.
- Bridge Indicators.**
United Electric Apparatus Co., Boston, Mass.
- Bridge Lights.**
Gray, Peter, & Sons, Boston.
- Bridge Paint.**
Antox Paint Co., New York.
- Dixon, Jos., Crucible Co., Jersey City, N. J.**
- Buckets Automatic Grab.**
Brown Hoisting Mach. Co., Cleveland, O.
- Williams, G. H., Co., Cleveland, O.**
- Buckets, Dump.**
Brown Hoisting Mach. Co., Cleveland, O.
- Industrial Supply & Equipment Co., Philadelphia, Pa.**
- Williams, G. H., Co., Cleveland, O.**
- Buckets, Excavating.**
Brown Hoisting Mach. Co., Cleveland, O.
- Industrial Supply & Equipment Co., Philadelphia, Pa.**
- Williams, G. H., Co., Cleveland, O.**
- Building Felt and Papers.**
Franklin Mfg. Co., Franklin, Pa.
- Bumping Posts.**
Mechanical Mfg. Co., Chicago.
- Railway & Traction Supply Co., Chicago.**
- Bunks.**
Haggard & Marcusson, Chicago.
- Burners, Lamp and Lantern.**
Gray, Peter & Sons, Boston, Mass.
- Cables.**
Central Electric Co., Chicago.
- Car Movers.**
Atlas Railway Supply Co., Chicago.
- Car Replacers.**
Johnson Wrecking Frog Co., Cleveland, O.
- Kalamazoo Railway Supply Co., Kalamazoo, Michigan.**
- Car Stoppers.**
Southern Railway Supply Co., St. Louis, Mo.
- Cars, Hand and Inspection (See Hand Cars, and Inspection Cars).**
- Cattle Guards.**
Calumet Supply Mfg. Co., Harvey, Ill.
- Kalamazoo Railway Supply Co., Kalamazoo, Mich.**
- Track Necessities Co., Chicago.**
- Chairs.**
A. H. Andrews Co., Chicago.
- Chisels.**
Hubbard & Co., Pittsburgh, Pa.
- Coal Miners' Tools.**
Hubbard & Co., Pittsburgh, Pa.
- Wyoming Shovel Co., Wyoming, Pa.**
- Concrete Mixers.**
Marsh Co., Chicago.
- Contact Switches.**
United Electric Apparatus Co., Boston, Mass.
- Continuous Joints.**
Atlas Supply Co., Chicago.
- Rail Joint Co., New York.**
- Cranes.**
Kalamazoo Railway Supply Co., Kalamazoo, Mich.
- Nichols, Geo. P., & Bros., Chicago.**
- Crayons.**
Dixon, Jos., Crucible Co., Jersey City, N. J.
- Crossing Belts.**
Hoeschen Manufacturing Co., Omaha, Neb.
- United Electric Apparatus Co., Boston, Mass.**
- Crossing Signs.**
Stonehouse Enameled Steel Sign Co., Denver, Colo.
- Crossings (See Frogs and Crossings).**
- Danger Signs.**
Stonehouse Enameled Steel Sign Co., Denver, Colo.
- Derails.**
Indianapolis Switch & Frog Co., Springfield, O.
- Desks.**
A. H. Andrews Co., Chicago.
- Door Hangers.**
Richards-Wilcox Mfg. Co., Aurora, Ill.
- Dump Cars.**
Clark Car Co., Pittsburgh, Pa.
- Kalamazoo Railway Supply Co., Kalamazoo, Mich.**
- Dump Wagons.**
Marsh, Geo., Co., Chicago.
- Electric Batteries.**
U. S. Light & Heating Co., New York.
- Waterbury Battery Co., Waterbury, Conn.**
- Electric Lights for Signal Lamps.**
Gray, Peter, & Sons, Boston, Mass.
- Engines, Gasoline (See Gasoline Engines).**
- Farm Gates.**
Iowa Gate Co., Cedar Falls, Ia.
- Fencing.**
Calumet Supply Mfg. Co., Harvey, Ill.
- Fence Posts.**
Calumet Supply Mfg. Co., Harvey, Ill.
- Fire Door Equipment.**
Richards-Wilcox Mfg. Co., Aurora, Ill.
- Forges, Combination.**
Track Necessities Co., Chicago.
- Forms, Collapsible.**
Concrete Form & Engine Co., Detroit, Mich.
- Marsh Co., Chicago.**
- Frictionless Rail.**
Frictionless Rail, Boston, Mass.
- Frogs and Crossings.**
Cincinnati Frog & Switch Co., Cincinnati, O.
- Frog, Switch & Mfg. Co., Carlisle, Pa.**
- Indianapolis Switch & Frog Co., Springfield, O.**
- Ramapo Iron Works, Hillburn, N. Y.**
- Weir Frog Co., Cincinnati.**
- Gasoline Cars.**
Associated Manufacturers Co., Waterloo, Iowa.
- Chicago Pneumatic Tool Co., Chicago.**
- Concrete Form & Engine Co., Detroit, Mich.**
- Fairmont Machine Co., Fairmont, Minn.**
- Kalamazoo Railway Supply Co., Kalamazoo, Mich.**
- Mudge, Burton W., & Co., Chicago.**
- Gasoline Engines.**
Associated Manufacturers Co., Waterloo, Ia.
- Concrete Form & Engine Co., Detroit, Mich.**
- Fairmont Machine Co., Fairmont, Minn.**
- Kalamazoo Railway Supply Co., Kalamazoo, Mich.**
- Mudge, Burton W. & Co., Chicago.**
- Gasoline Motor Cars (See Motor Cars, Gasoline).**
- Gates, Right of Way.**
Iowa Gate Co., Cedar Falls, Ia.
- Grab Buckets.**
Brown Hoisting Machinery Co., Cleveland, Ohio.
- Industrial Supply & Equipment Co., Philadelphia, Pa.**
- Williams, G. H., Co., Cleveland, O.**
- Graphite.**
Dixon, Jos., Crucible Co., Jersey City, N. J.
- Hack Saws.**
Track Necessities Co., Chicago.
- Hand Car Motors.**
Associated Manufacturers Co., Waterloo, Iowa.
- Concrete Form & Engine Co., Detroit, Mich.**
- Fairmont Machine Co., Fairmont, Minn.**
- Mudge, Burton W. & Co., Chicago.**
- Hand Cars.**
Associated Manufacturers Co., Waterloo, Iowa.
- Kalamazoo Railway Supply Co., Kalamazoo, Mich.**
- Heating and Ventilating Systems.**
Gale Installation Co., Chicago.
- Hoes.**
Hubbard & Co., Pittsburgh, Pa.
- Hoisting Machinery.**
Brown Hoisting Mach. Co., Cleveland, O.
- Hind Hoisting Machinery Co., Buffalo, N. Y.**
- Verona Tool Works, Pittsburgh, Pa.**
- I-Beam Carrying System.**
Richards-Wilcox Mfg. Co., Aurora, Ill.
- Inspection Cars.**
Associated Manufacturers Co., Waterloo, Ia.
- Chicago Pneumatic Tool Co., Chicago.**
- Light Inspection Car Co., Hagerstown, Ind.**
- Kalamazoo Railway Supply Co., Kalamazoo, Mich.**
- Mudge, Burton W., & Co., Chicago.**
- Insulation and Insulating Material.**
Central Electric Co., Chicago.
- Okonite Co.**
- Lamps and Lanterns.**
Gray, Peter, & Sons (Inc.), Boston.
- Latches.**
Richards-Wilcox Mfg. Co., Aurora, Ill.
- Lightning Arresters.**
United Electric Apparatus Co., Boston, Mass.
- Line Material.**
Electric Ry. & Equip. Co., Cincinnati, O.
- Locks, Sliding Door.**
Richards-Wilcox Mfg. Co., Aurora, Ill.
- Locomotive Cranes.**
Brown Hoisting Machinery Co., Cleveland, O.
- Locomotive Replacers.**
Johnson Wrecking Frog Co., Cleveland, O.
- Lubricants, Graphite.**
Dixon, Jos., Crucible Co., Jersey City, N. J.
- Lubrication, Graphite.**
Dixon, Jos., Crucible Co., Jersey City, N. J.
- Maintenance of Way Supplies.**
Hubbard & Co., Pittsburgh.
- Kalamazoo Railway Supply Co., Kalamazoo, Mich.**
- Manganese Frogs and Crossings.**
Cincinnati Frog & Switch Co., Cincinnati, O.
- Frog, Switch & Mfg. Co., Carlisle, Pa.**
- Indianapolis Switch & Frog Co., Springfield, O.**
- Ramapo Iron Works, Hillburn, N. Y.**
- Weir Frog Co., Cincinnati, O.**
- Mast Arms.**
Electric Ry. Equipment Co., Cincinnati.
- Metal Protecting Paints.**
Antox Paint Co., New York.
- Dixon, Joseph, Crucible Co., Jersey City, N. J.**
- Mining Instruments.**
R. Seelig & Son, Chicago.
- Molds, Pipe and Culvert.**
Concrete Form & Engine Co., Detroit, Mich.
- Motor Cars.**
Associated Manufacturers Co., Waterloo, Ia.
- Chicago Pneumatic Tool Co., Chicago.**
- Concrete Form & Engine Co., Detroit, Mich.**
- Fairmont Machine Co., Fairmont, Minn.**
- Kalamazoo Railway Supply Co., Kalamazoo, Mich.**
- Mudge, Burton W., & Co., Chicago.**
- Motors, Gasoline.**
Associated Manufacturers Co., Waterloo, Ia.
- Concrete Form & Engine Co., Detroit, Mich.**
- Fairmont Machine Co., Fairmont, Minn.**
- Mudge, Burton W., & Co., Chicago.**
- Oil Cans.**
Gray, Peter, & Sons, Boston, Mass.
- Oil Storage Systems.**
Bowser, S. F., & Co., Ft. Wayne, Ind.
- Oil Tanks.**
Bowser, S. F., & Co., Ft. Wayne, Ind.
- Wm. Graver Tank Wks., E. Chicago, Ind.**
- Overhead Carriers.**
Richards-Wilcox Mfg. Co., Aurora, Ill.
- Paints.**
Antox Paint Co., New York.
- Dixon, Joseph, Crucible Co., Jersey City, N. J.**
- Parallel Door Hangers.**
Richards-Wilcox Mfg. Co., Aurora, Ill.
- Parallel Door Hardware.**
Richards-Wilcox Mfg. Co., Aurora, Ill.
- Pencils.**
Dixon, Jos., Crucible Co., Jersey City, N. J.
- Picks.**
Hubbard & Co., Pittsburgh, Pa.
- Plate. (See Tie Plates.)**
- Plows, Unloading.**
Bucyrus Co., S. Milwaukee, Wis.
- Pole Line Material.**
Electric Ry. Equip. Co., Cincinnati.
- Hubbard & Co., Pittsburgh, Pa.**
- Poles, Steel.**
Electric Ry. Equip. Co., Cincinnati.
- Post Hole Diggers.**
Hubbard & Co., Pittsburgh, Pa.
- Power Plants.**
Gale Installation Co., Chicago.
- Push Cars.**
Kalamazoo Railway Supply Co., Kalamazoo, Mich.
- Publications.**
Clarke, Myron C., Pub. Co., Chicago.
- Push Cars.**
Associated Manufacturers Co., Waterloo, Ia.
- Pumps.**
Blackmer Rotary Pump, Power & Mfg. Co., Petoskey, Mich.
- Pumps, Oil.**
Bowser, S. F., & Co., Ft. Wayne, Ind.
- Rail Benders.**
Kalamazoo Railway Supply Co., Kalamazoo, Mich.
- Track Necessities Co., Chicago.**
- Rail Braces.**
Atlas Railway Supply Co., Chicago.
- Cincinnati Frog & Switch Co., Cincinnati, O.**
- Indianapolis Switch & Frog Co., Springfield, O.**
- Weir Frog Co., Cincinnati.**

CLASSIFIED INDEX—Continued.

- Rail Drills.**
Indianapolis Switch & Frog Co., Springfield, O.
- Rail Joint Clamp.**
Track Necessities Co., Chicago.
- Rail Joints.**
Atlas Railway Supply Co., Chicago.
International Interlocking Rail Joint Co., Chicago.
- Rail Joint Co., New York City.**
Weir Frog Co., Cincinnati, O.
- Railway Equipment and Supplies.**
American Valve & Meter Co., Cincinnati, O.
Atlas Railway Supply Co., Chicago.
Frog, Switch & Mfg. Co., Carlisle, Pa.
Indianapolis Switch & Frog Co., Springfield, O.
Industrial Supply & Equipment Co., Philadelphia, Pa.
Kalamazoo Railway Supply Co., Kalamazoo, Mich.
Mudge, Burton W. & Co., Chicago.
Rail Joint Co., New York.
Ramapo Iron Works, Hillburn, N. Y.
Weir Frog Co., Cincinnati.
- Relays, Track.**
United Electric Apparatus Co., Boston, Mass.
- Replacers, Car and Engine.**
Johnson Wrecking Frog Co., Cleveland, O.
- Retorts, Timber Preserving Plant.**
Wm. Graver Tank Works, E. Chicago, Ind.
- Right-of-Way Gates.**
Iowa Gate Co., Cedar Falls, Ia.
- Roofing Materials, Asbestos.**
Franklin Mfg. Co., Franklin, Pa.
- Rotary Pumps.**
Blackmer Rotary Pump, Power & Mfg. Co., Petoskey, Mich.
- Roundhouse Asbestos.**
Franklin Mfg. Co., Franklin, Pa.
- Screw Spikes.**
Hart Steel Co., Elyria, O.
- Section Cars, Gasoline.**
Associated Manufacturers Co., Waterloo, Ia.
Chicago Pneumatic Tool Co., Chicago.
Concrete Form & Engine Co., Detroit, Mich.
Kalamazoo Railway Supply Co., Kalamazoo, Mich.
Mudge, Burton W. & Co., Chicago, Ill.
- Settees.**
A. H. Andrews Co., Chicago.
- Sheathing, Asbestos.**
Franklin Mfg. Co., Franklin, Pa.
- Sheet Metal.**
Gray, Peter, & Sons, Boston.
- Shingles, Asbestos.**
Franklin Mfg. Co., Franklin, Pa.
- Shovel Handles.**
Wyoming Shovel Wks., Wyoming, Pa.
- Shovels, Spades and Scoops.**
Hubbard & Co., Pittsburg, Pa.
Wyoming Shovel Wks., Wyoming, Pa.
- Signal Accessories.**
United Electric Apparatus Co., Boston, Mass.
- Signal Lamps.**
Gray, Peter, & Sons, Boston.
- Signs.**
Stonehouse Enamelled Steel Co., Denver, Colo.
- Smoke Jacks, Asbestos.**
Franklin Mfg. Co., Franklin, Pa.
- Spikes.**
Dillworth Porter & Co., Pittsburg.
Hart Steel Co., Elyria, O.
- Station Settees.**
A. H. Andrews Co., Chicago.
- Steam Shovels.**
Bucyrus Co., S. Milwaukee, Wis.
- Steel Bumping Posts.**
Railway & Traction Supply Co., Chicago.
- Steel Bunks.**
Haggard & Marcusson Co., Chicago.
- Steel Forms.**
Concrete Form & Engine Co., Detroit, Mich.
- Steel Gates.**
Iowa Gate Co., Cedar Falls, Ia.
- Steel Plate Work.**
Wm. Graver Tank Works, E. Chicago, Ind.
- Storage Batteries.**
U. S. Light & Heating Co., New York.
- Striking Hammers.**
Hubbard & Co., Pittsburg, Pa.
- Switch Lanterns.**
Gray, Peter, & Sons, Boston.
- Switch Rods.**
Weir Frog Co., Cincinnati, O.
Ramapo Iron Works, Hillburn, N. Y.
- Switches and Switch Stands.**
American Valve & Meter Co., Cincinnati, O.
Atlas Railway Supply Co., Chicago.
Cincinnati Frog & Switch Co., Cincinnati.
Frog, Switch & Mfg. Co., Carlisle, Pa.
Indianapolis Switch & Frog Co., Springfield, O.
Ramapo Iron Works, Hillburn, N. Y.
Weir Frog Co., Cincinnati.
- Switchboard Adjusters.**
Weir Frog Co., Cincinnati.
- Tank Cars.**
Wm. Graver Tank Works, E. Chicago, Ind.
- Tanks and Tank Fixtures.**
Bowser, S. F. & Co., Ft. Wayne, Ind.
Wm. Graver Tank Works, E. Chicago, Ind.
Kalamazoo Railway Supply Co., Kalamazoo, Mich.
- Telegraph and Telephone Supplies.**
Central Electric Co., Chicago.
Hubbard & Co., Pittsburg.
- Terminal Blocks.**
United Electric Apparatus Co., Boston, Mass.
- Tie Plate Gage.**
Track Necessities Co., Chicago.
- Tie Plates.**
Atlas Railway Supply Co., Chicago.
Dillworth Porter & Co., Pittsburg.
Hart Steel Co., Elyria, O.
- Tie Surfacers.**
Track Necessities Co., Chicago.
- Tie Tongs.**
Track Necessities Co., Chicago.
- Tool Grinders.**
Track Necessities Co., Chicago.
- Timber Preserving Plant Machinery.**
Wm. Graver Tank Works, E. Chicago, Ind.
- Track Drills.**
Cooks Standard Tool Co., Kalamazoo, Mich.
Kalamazoo Railway Supply Co., Kalamazoo, Mich.
- Track Jacks.**
Cooks Standard Tool Co., Kalamazoo, Mich.
- Track Laying Cars.**
Kalamazoo Railway Supply Co., Kalamazoo, Mich.
- Track Materials.**
Atlas Railway Supply Co., Chicago.
Frog, Switch & Mfg. Co., Carlisle, Pa.
Indianapolis Switch & Frog Co., Springfield, O.
Ramapo Iron Works, Hillburn, N. Y.
Track Necessities Co., Chicago.
Verona Tool Works, Pittsburg, Pa.
Weir Frog Co., Cincinnati.
- Track Tools.**
Cooks Standard Tool Co., Kalamazoo, Mich.
- Hubbard & Co., Pittsburg, Pa.**
Kalamazoo Railway Supply Co., Kalamazoo, Mich.
- Track Necessities Co., Chicago.**
Verona Tool Works, Pittsburg, Pa.
Wyoming Shovel Works, Wyoming, Pa.
- Transfer Tables.**
Nichols, Geo. P., & Bro., Chicago.
- Turntable Tractors.**
Nichols, Geo. P., & Bro., Chicago.
- Turntables.**
Nichols, Geo. P., & Bro., Chicago.
- Valve Grease, Graphite.**
Dixon, Joseph, Crucible Co., Jersey City, N. J.
- Velocipede Cars.**
Kalamazoo Railway Supply Co., Kalamazoo, Mich.
- Ventilating System.**
Gale Installation Co., Chicago.
- Washers.**
Hubbard & Co., Pittsburg, Pa.
- Water Columns.**
Kalamazoo Railway Supply Co., Kalamazoo, Mich.
- Water Coolers.**
Gray, Peter, & Sons, Boston.
- Water Filters.**
Pittsburg Filter Mfg. Co., Pittsburg, Pa.
- Water Softeners.**
Booth, L. M., Co., New York, N. Y.
Wm. Graver Tank Works, E. Chicago, Ind.
Pittsburg Filter Mfg. Co., Pittsburg, Pa.
- Wedges.**
Hubbard & Co., Pittsburg, Pa.
- Wheelbarrows.**
Kalamazoo Railway Supply Co., Kalamazoo, Mich.
- Wing Fence Aprons.**
Calumet Supply Co., Calumet, Ill.
- Wires.**
Central Electric Co., Chicago.
- Wire Tapes and Cords.**
Central Electric Co., Chicago.
- Wrecking Frogs.**
Johnson Wrecking Frog Co., Cleveland, O.
- Wrenches.**
Coe's Wrench Co., Worcester, Mass.

Nichols Transfer Tables Turntable Tractors

GEO. P. NICHOLS & BRO.

1090 OLD COLONY BUILDING, CHICAGO

BOOTH WATER SOFTENER

Clean Boilers No wasted fuel Ask for free Booklet

L. M. Booth Co., 130 Liberty Street, New York

The Frog Switch & Mfg. Co.

CARLISLE, PA.

RAIL and MANGANESE TRACK WORK

Spring Frogs
Rigid Frogs
Crossings



Split Switches
Switch Stands
Rail Braces

TUBULAR POLES IRON OR STEEL



for
Signal, Electric
Railway and
Lighting Service.
Trolley Brackets
Plain and Orna-
mental for Wood
and Iron Poles.
Line Material.
Mast Arms. ❖ ❖

Let us estimate
on your requirements

ELECTRIC RAILWAY EQUIPMENT CO.

General Office, 2900 Corman Avenue
CINCINNATI, OHIO

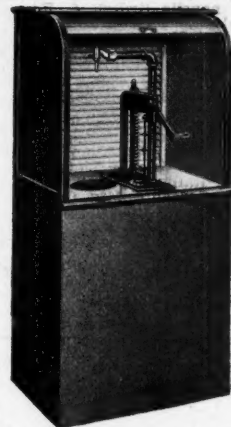
A Tireless Iron Clerk

To be always on duty
and never make a mistake
are the features of Bow-
ser automatic storage and
measuring tanks. They
measure and automatic-
ally record the oil used.
They are made in mul-
tiple units, can be used
for all kinds of oils, re-
duce fire risk and prevent loss by overflow.



149 Railroads
use them in the
U. S. A. and 33 in
foreign countries.

Send for free illustrated
book, giving list of users.



S. F. BOWSER & CO., Inc.

Home Plant and General Offices: Box 2054 FT. WAYNE, IND., U. S. A.

SALES OFFICES IN ALL CENTERS AND
REPRESENTATIVES EVERYWHERE

Original patentees and manufacturers of standard, self-meas-
uring, hand and power-driven pumps, large and small tanks,
gasoline and oil storage and distributing systems, self-register-
ing pipe line measures, oil filtering and circulating systems,
dry cleaner's systems, etc.

ESTABLISHED 1885

Alphabetical Index to Advertisers

American Valve & Meter Co.	13	Haggard & Marcussen	23
Antox Paint Co.	17	Hart Steel Co.	25
Andrews, A. H., Co.	8	Hoeschen Mfg. Co.	8
Associated Manufacturers Co.	7	Hubbard & Co.	2
Atlas Railway Supply Co.	8	Indianapolis Switch & Frog Co.	26
Belle Isle Motor Co.	4	Industrial Supply & Equipment Co.	15
Booth, L. M., Co.	21	International Interlocking Rail Joint Mfg. Co.	3
Bowser, S. F., & Co.	22	Iowa Gate Co.	17
Blackmer Rotary Pump, Power & Mfg. Co.	18	Johnson Wrecking Frog Co.	14
Broadway Central Hotel	12	Kalamazoo Railway Supply Co.	24
Brown Hoisting Machine Co.	12	Koehring Machine Co.	5
Bucyrus Co.	4	Light Inspection Car Co.	18
Calumet Supply Mfg. Co.	9	Massee Country School	12
Central Electric Co.	5	Mechanical Mfg. Co.	23
C. H. & E. Manufacturing Co.	7	Morton Mfg. Co.	11
Chicago Ironite Waterproofing Co.	9	Mudge, Burton W., & Co.	9
Chicago Pneumatic Tool Co.	6	Nichols, Geo. P., & Bro.	21
Cincinnati Frog & Switch Co.	21	Okonite Co.	5
Clark Car Co.	Front Cover	Pittsburgh Filter Mfg. Co.	18
Clark, Myron C., Pub. Co.	23	Railway & Traction Supply Co.	17
Coes Wrench Co.	19	Rail Joint Co., The	13
Concrete Form & Engine Co.	4	Ramapo Iron Works	7
Cook's Standard Tool Co.	14	Richards-Wilcox Mfg. Co.	13
Dilworth, Porter & Co.	26	Southern Railway Supply Co.	17
Dixon, Jos., Crucible Co.	23	Steel Concrete Construction Co.	10
Egleston, M. J.	9	Stonehouse Enameled Steel Sign Co.	14
Electric Railway Equipment Co.	22	Track Necessities Co.	4
Elyria Iron & Steel Co.	25	United Electric Apparatus Co.	16
Fairmont Machine Co.	25	U. S. Light & Heating Co.	15
Franklin Mfg. Co.	24	Verona Tool Works	6
Frictionless Rail, The	17	Waterbury Battery Co.	3
Frog, Switch & Mfg. Co.	21	Weir Frog Co.	12
Gale Installation Co.	13	Western Wheeled Scraper Co.	5
Graver, Wm., Tank Works	24	Williams, G. H., Co.	25
Gray, Peter, & Sons	12	Wyoming Shovel Works	9



"Talk about hard work," sighed old Jerry as he sat watching a squeaking and groaning mass of clothes lines, "the reverse lever in Old 689 used to put a crick in my back every time I pulled it.

"That's before I got wise to usin' flake graphite. Flake graphite, and I mean the Dixon kind of course, is the only thing I ever knew to satisfy both the boys and the road. It makes an easier and better day's work for the man in the cab, with less worry and no tired-out feeling to greet the folks at home.

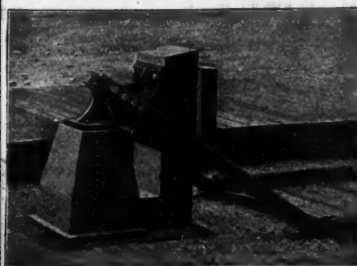
"And I just wish I had the money that the road saves in oil and coal bills each year. It's enough to start a club for the boys on the retired list who started the 'savin' by writing for booklet and sample No. 104."

**Joseph Dixon
Crucible Co.**

Established 1827

Jersey City - N. J.

40-C



ELLIS PATENT BUMPING POST

Noted for Simplicity, Strength and Lasting Qualities. Adapted to all positions.

Mechanical Mfg. Co.,
CHICAGO, ILL.

IF YOU can find an error in the May issue of

The Monthly Official Railway List

you will be given a year's subscription to

Railway Engineering or your subscription will be extended one year.

See Offer on Page 113
May Issue of

**The Monthly
Official Railway List**



Showing Head Room, Height, Etc.

"Tiger" Steel Bunks

an important factor in securing and keeping a

GOOD CLASS OF WORKMEN

Ultimately
Cheaper
Than Wood
Bunks.
Infinitely
More
Comfortable
and
Sanitary



Built to
Stand
Hard
Knocks.
It's
Bug-Proof

HAGGARD & MARCUSSON COMPANY
1120 WEST 37th ST., CHICAGO

The Trackman's Helper

Revised Edition—by J. KINDELAN

A Practical Guide for Track Foremen

Thirtieth Thousand

"It is so very plain and easily understood, its value to men of ordinary education cannot be estimated."—D. A. Dale, Roadmaster, West Shore Ry.

"I find the Revised Trackman's Helper the most generally instructive and useful book for trackmen that is now obtainable. I think every Track Foreman and Roadmaster should have a copy of it."—D. Sweeney, Roadmaster, C., R. I & P. Ry.

350 pages; fully illustrated, 5½x7½ inches.
Price, \$1.50, net postpaid.

Practical Switch Work

By D. H. LOVELL

Division Superintendent Pennsylvania Ry.

An Instructor and Guide for Roadmasters, Section Foremen and Construction Foremen

This book is presented in a very clear manner, which is at once simple, thorough and practical.

The contents include chapters on General Turn-outs; Stub and Split Switches; Analysis of Curves; and a large number of tables for the quick and correct construction of any switch.

Cloth, 174 pages; 4½x6¼ inches.
Price, \$1.00, net postpaid.

Maintenance of Way Standards, by F. A. Smith, M. E., C. E. - Price, \$1.50
Standard Turn Outs on American Railroads, by F. A. Smith - Price, 1.00
Railway Curves, by F. A. Smith - - - - - Price, 1.00

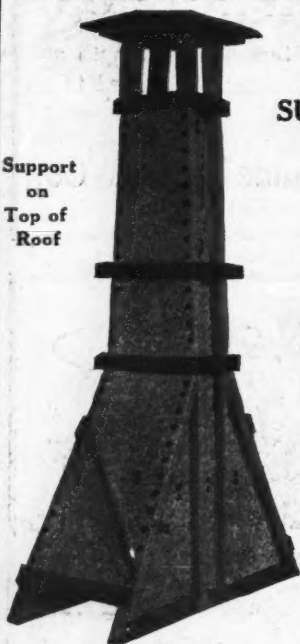
Descriptive Circulars upon Application

The Myron C. Clark Publishing Co.

Heisen Building, Chicago

The FRANKLIN ASBESTOS SMOKE JACK

Support
on
Top of
Roof



ASBESTOS
RAILWAY
SUPPLIES, EVERY
DESCRIPTION

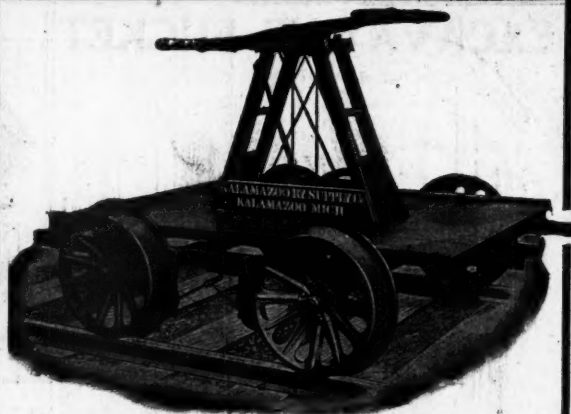
ASBESTOS
"CENTURY"
SHINGLES

CORRUGATED
SHEATHING

ASBESTOS
FLAT
LUMBER

Requires no paint.
No rust. Everlast-
ing and fireproof.

Franklin Manufacturing Co., Franklin,
PENNA.



Kalamazoo Hand Cars

are equipped with the Kalamazoo Improved Reinforced Pressed Steel Wheel, giving 50 to 100 per cent greater wear than any other wheel of similar design or weight on the market. The car has stout galleys frame, thoroughly trussed, has taper wheel and pinion fits on axles, machine cut gears, flexible steady box and double acting brake.

16 Different Styles, Standard or Special

Catalogue of Track and Railway
Supplies on Request

Kalamazoo Railway Supply Co.
Kalamazoo, Mich.

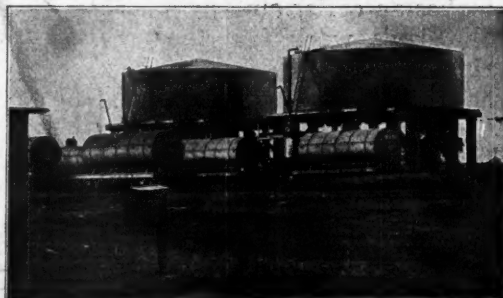
Western Representative: Universal Railway Supply Co., Chicago

STEEL TANKS AND PLATE WORK



Water Softeners

**GRAVER
PRODUCTS**
FAVORABLY KNOWN
FOR
FORTY YEARS



Water Tower Tanks

Steel Water Tanks — Creosoting Tanks — Sand Storage — Culverts —
Bridge Piers — Smoke Stacks — Oil House Tanks — Car Tanks —
Stand Pipes — Car Wheel Annealing Pits — Pressure Tanks —

ALL KINDS OF TANKS FOR FUEL OIL BURNING SYSTEMS

1,000 to 20,000 Gallon Tanks in Stock. Immediate Shipment.

THE BARTLETT-GRAVER WATER SOFTENER HAS NO EQUAL

WM. GRAVER TANK WORKS, East Chicago, Ind.

DENVER, COLO.
1718 California Street

SALT LAKE CITY, UTAH
109 W. Second St. South

LOS ANGELES, CAL.
312 Security Bldg.

EXCAVATING BUCKET



BEST ON EARTH



Standard Bucket
Type "C" Closed

These
BUCKETS

are the



Standard Bucket
Type "D" Closed

**Most Durable Buckets Made. Built Entirely
of Steel**

IN ALL SIZES

A BUCKET FOR EVERY SERVICE

Write

THE G. H. WILLIAMS CO.
CLEVELAND, OHIO



Single Rope Bucket
Closed View

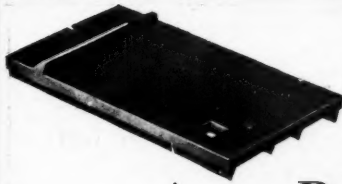
**FOR
INFORMATION**

and

PRICES



Single Rope Bucket
Open View

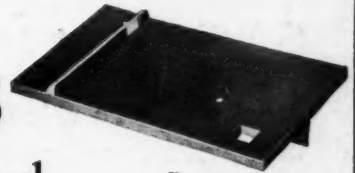


A

Tie Plates

Rolled from New Steel

With Longitudinal or Transverse Flanges and Flat Bottom

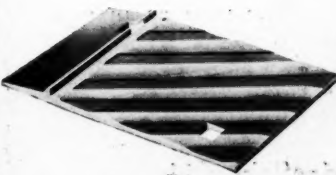


B



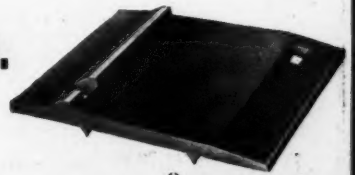
Manhattan Compromise Joints

Steel Casting, Base Supporting throughout, Reinforced
by its girder construction



F

THE ELYRIA IRON & STEEL CO.
ELYRIA, OHIO



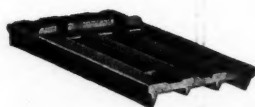
G

DILWORTH, PORTER AND CO., Ltd.
PITTSBURGH, PA.

TIE PLATES AND SPIKES



GOLDIE PLATE

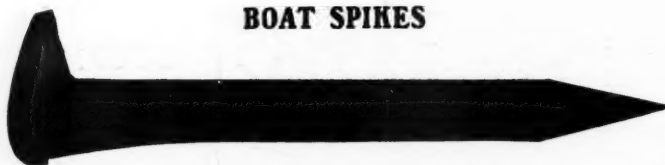


DILWORTH FLANGE PLATE



HARRIMAN PLATE

**Standard
and
Special
Railroad
Spikes**



BOAT SPIKES

**Goldie
Perfect
Spikes
a Specialty**

All spikes are shipped in steel hooped kegs

THE Merit of "Indianapolis" Products appeal to the discriminating *Engineer and Roadway Official*, who is progressive, practical and recognizes the value of Final efficiency and economy rather than low first cost with excessive maintenance and interrupted operating schedule.

He wants to know that all

Materials are strictly and absolutely first quality throughout. Nothing but first quality rails and fittings go into any part of our product.

Nothing but American "Stag" Brand of manganese (the most dependable and serviceable metal of its kind yet produced) is used in our manganese work and in combination with scientific designing and liberal sections with a maximum safety factor—Nothing is better (no exceptions).

He wants to know that

Workmanship and Methods are confined to the best modern practices only.

Our works are located at Springfield, Ohio.

We have every modern and improved facility for the most economical production of strictly High Class Product.

But employ no practices or methods to lessen the cost of production that are in any way detrimental to the steel or other material.

All rails are drilled—never punched.

All bolted structures are UNIT DRILLED and bolts a driving fit.

All rivets are compression driven—70 tons maximum pressure.

All manganese is accurately fitted and ground at a low temperature.

Result—Costs some more—worth much more.

He wants to know that

Design embodies strength and endurance and eliminates weakness and failures.

"Conservation of Energy" is a science which applied to Track and Rolling Stock has done more than any other one thing to bring into favor and recognition the "Indianapolis" Designs and their adoption by the leading and best roads in the country.

Our designs are the results of our own experience and observation together with a composite of suggestions of the most able Engineers and track men.

Designs that favor and protect both the structure and rolling stock.

Indianapolis built up designs of Regular Construction are reinforced and self-contained, prolong the life of the work.

Indianapolis R-N-R Designs of Manganese Frogs and Crossings have revolutionized maintenance and when introduced were a radical departure from any known practice, yet have been freely adopted and are extensively in use on nearly all roads of importance where purchases are not restricted.

Indianapolis R-N-R Designs have features of exclusive merit not found in any others.

Indianapolis Manganese Designs of Insert Special Work, were the first to feature the renewal of rail parts without removing from the track for repairs.

He wants to know

where to get what he needs.

It is made at

Springfield, Ohio.

